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Otobe

(10) **Patent No.: US 9,144,989 B2**
(45) **Date of Patent: Sep. 29, 2015**

(54) **LIQUID CARTRIDGE AND LIQUID EJECTING APPARATUS**

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(73) Assignee: **BROTHER KOGYO KABUSHIKI KAISHA**, Nagoya-Shi, Aichi-Ken (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **14/166,263**

(22) Filed: **Jan. 28, 2014**

(65) **Prior Publication Data**

US 2014/0139598 A1 May 22, 2014

Related U.S. Application Data

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(51) **Int. Cl.**
B41J 2/175 (2006.01)
B41J 29/38 (2006.01)

(52) **U.S. Cl.**
CPC ***B41J 2/17543*** (2013.01); ***B41J 2/1752*** (2013.01); ***B41J 2/1753*** (2013.01); ***B41J 2/17513*** (2013.01); ***B41J 2/17523*** (2013.01); ***B41J 2/17546*** (2013.01); ***B41J 2/17553*** (2013.01); ***B41J 29/38*** (2013.01)

(58) **Field of Classification Search**
CPC B41J 2/175; B41J 2/17503; B41J 2/17506; B41J 2/17509; B41J 2/17543; B41J 2/17546; B41J 2/1752; B41J 2/1755
USPC 347/86
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,113,229	A	9/2000	Gunther et al.	
6,378,971	B1 *	4/2002	Tamura et al.	347/7
2007/0268347	A1 *	11/2007	Amano et al.	347/86

(Continued)

FOREIGN PATENT DOCUMENTS

EP	0 826 505	A2		3/1998
EP	1285764	A1	*	2/2003

(Continued)

OTHER PUBLICATIONS

International Search Report and Written Opinion issued in PCT/JP2011/067255, mailed Aug. 22, 2011.

(Continued)

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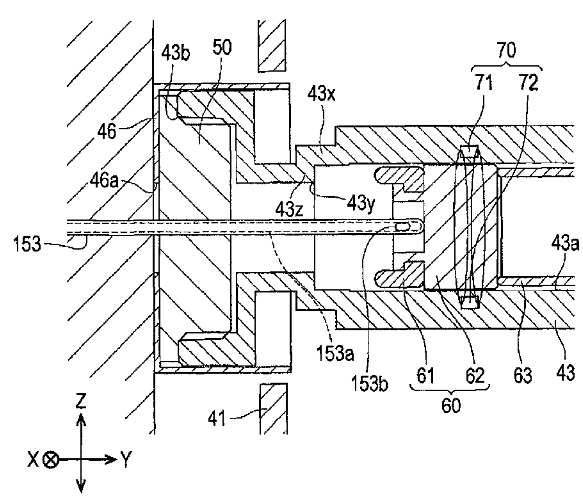
Assistant Examiner — Scott A Richmond
(74) *Attorney, Agent, or Firm* — Merchant & Gould PC

(57) **ABSTRACT**

In a liquid cartridge, a liquid storing section defines a liquid storing chamber storing liquid, and a channel section defines a channel in fluid communication with the liquid storing chamber. A field forming section forms a field that changes depending on a position of a movable member that is movable in the channel. A power-source potential is inputted to a power-source terminal, and a ground potential is inputted to a ground terminal. A sensor is electrically connected with the power-source terminal and the ground terminal, and generates a potential based on the position of the movable member by being disposed in the field formed by the field forming section. An output terminal outputs the potential generated by the sensor. The sensor generates the potential higher than a ground potential regardless of the position of the movable member.

12 Claims, 23 Drawing Sheets



(56) **References Cited**

U.S. PATENT DOCUMENTS

2008/0231676	A1	9/2008	Shimizu	
2009/0322838	A1	12/2009	Wanibe et al.	
2010/0091070	A1 *	4/2010	Kimura	347/50
2010/0110154	A1	5/2010	Iwamura et al.	
2010/0220127	A1	9/2010	Levy et al.	
2010/0289847	A1	11/2010	Ishizawa et al.	

FOREIGN PATENT DOCUMENTS

EP	2 202 078	A1	6/2010
JP	61-158460	A	7/1986
JP	8-80618	A	3/1996
JP	11-286123	A	10/1999
JP	2000-225692	A	8/2000
JP	2010-208288	A	9/2010
JP	2010-240979	A	10/2010

OTHER PUBLICATIONS

Extended European Search Report issued in the counterpart European application EP11870059.0, mailed Apr. 1, 2015.

* cited by examiner

FIG. 1

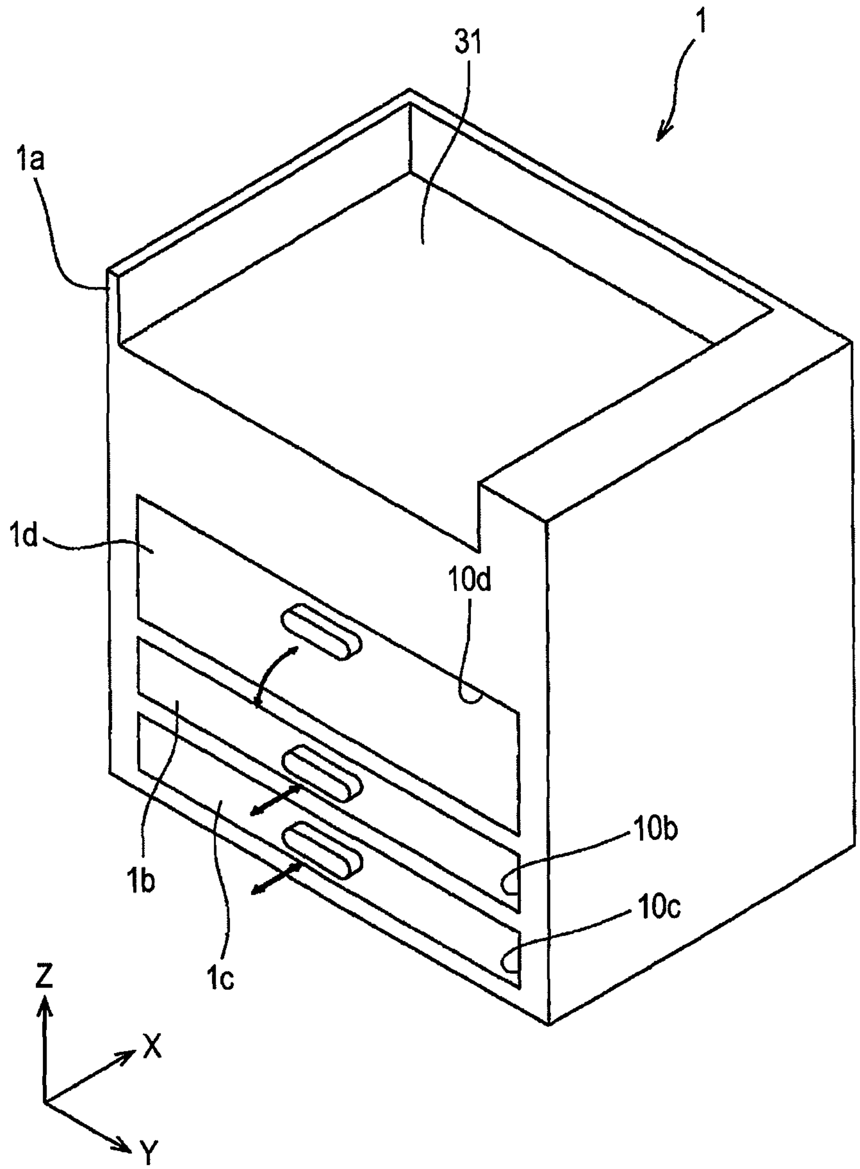
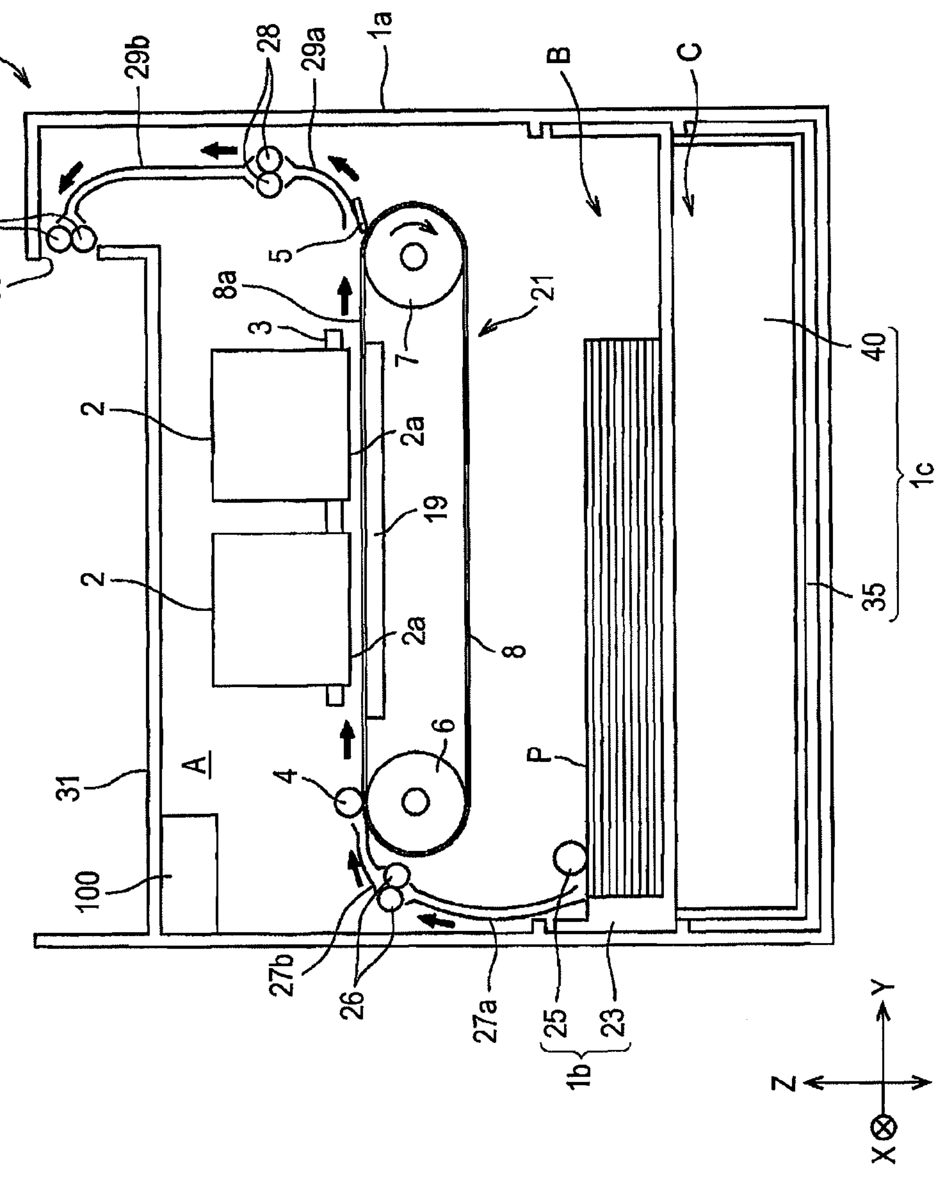


FIG. 2


1
1a
29b
28
29a
B
C
28
30
5
8a
21
3
7
40
2
2a
19
1c
2
2a
35
8
31
A
6
P
4
100
27b
26
27a
25
23
1b
Z
Y
X

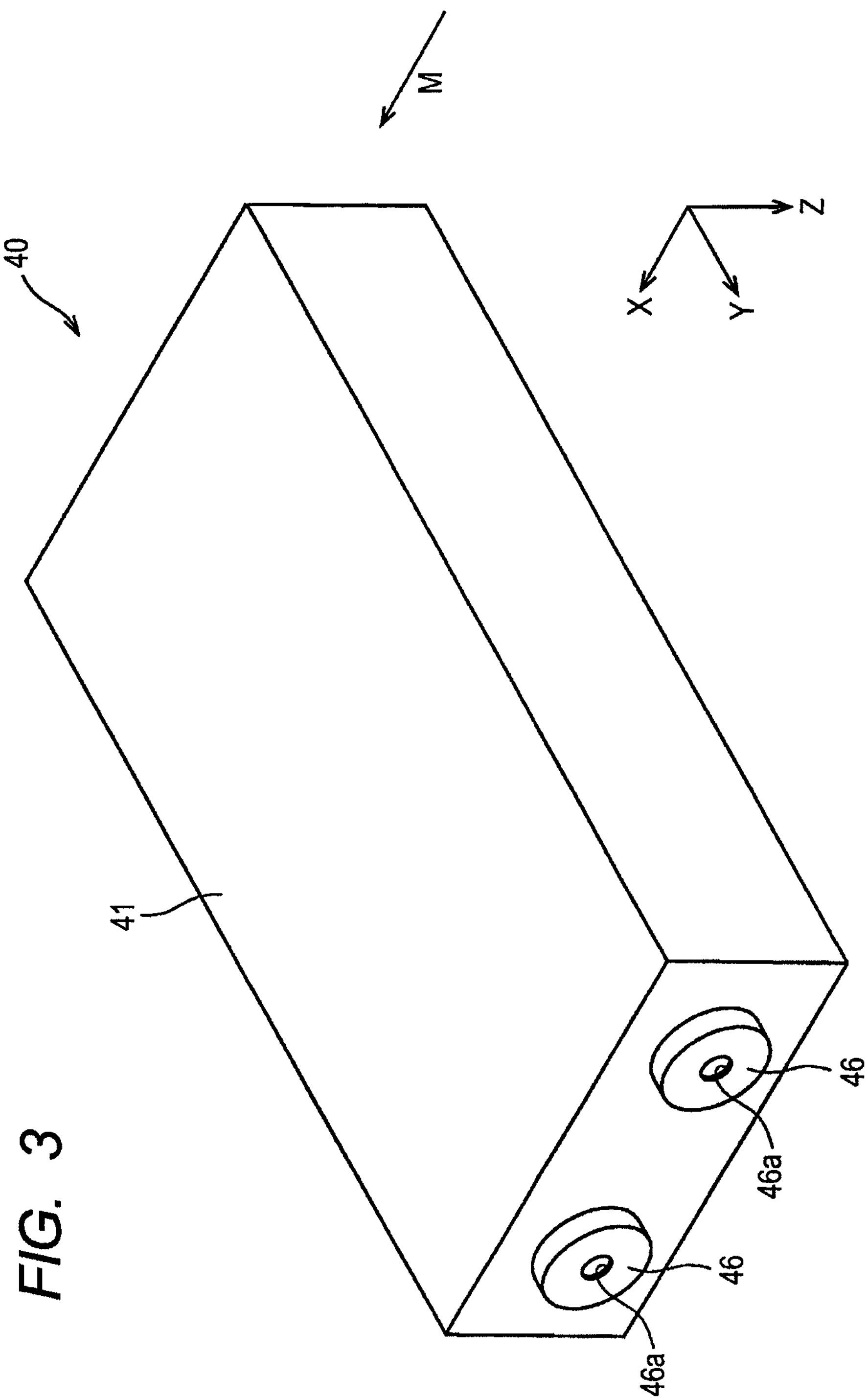


FIG. 3

FIG. 4

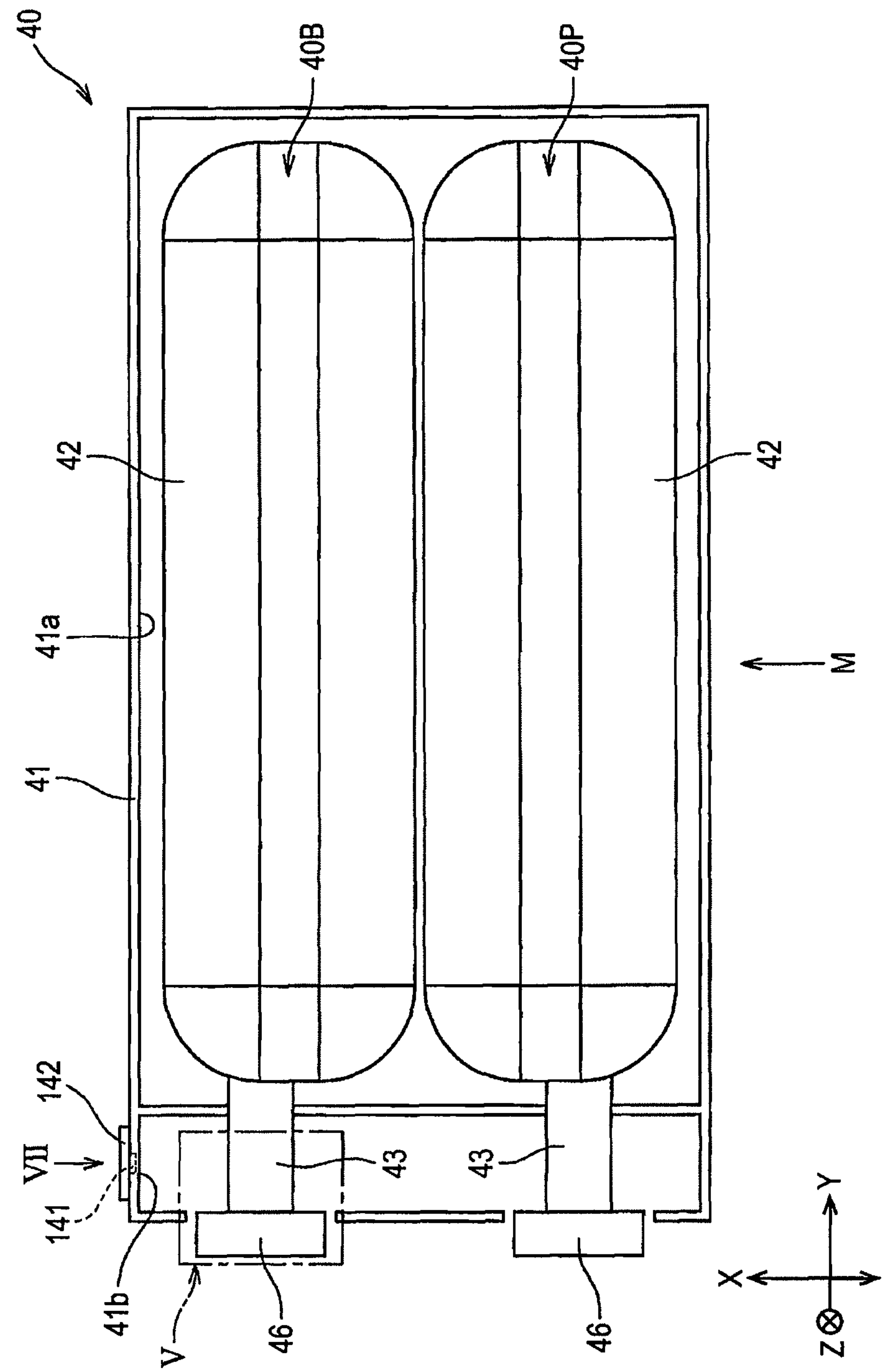
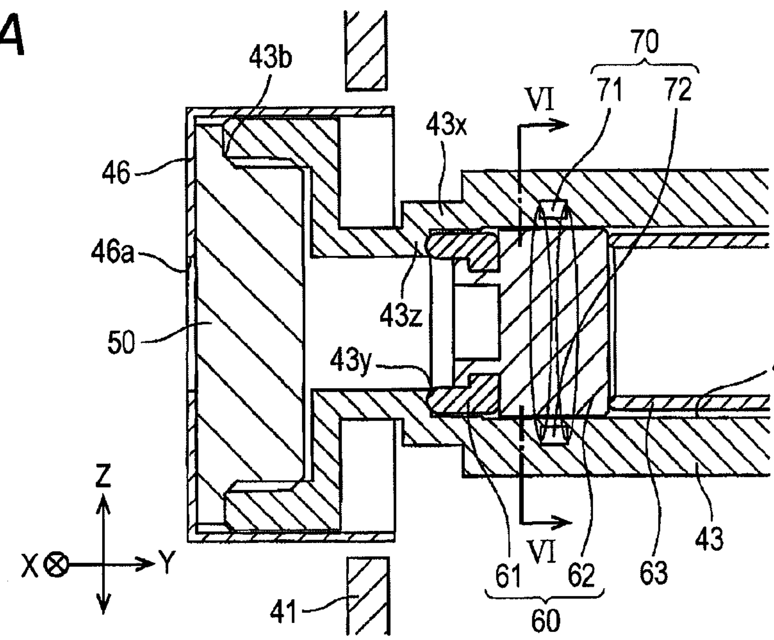
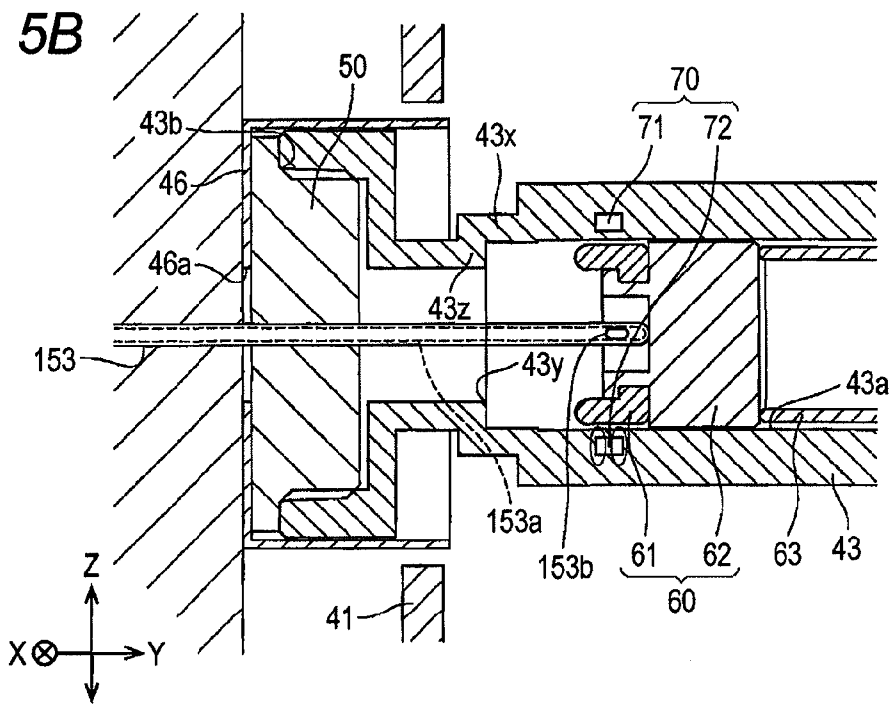


FIG. 5A



70
71
72
43b
VI
43x
46
46a
50
43z
43y
43a
Z
X
Y
VI
61
62
63
43
41
60

FIG. 5B



50
70
71
72
43b
43x
46
46a
43z
153
43y
43a
153a
153b
61
62
63
43
60
Z
X
Y
41

FIG. 6

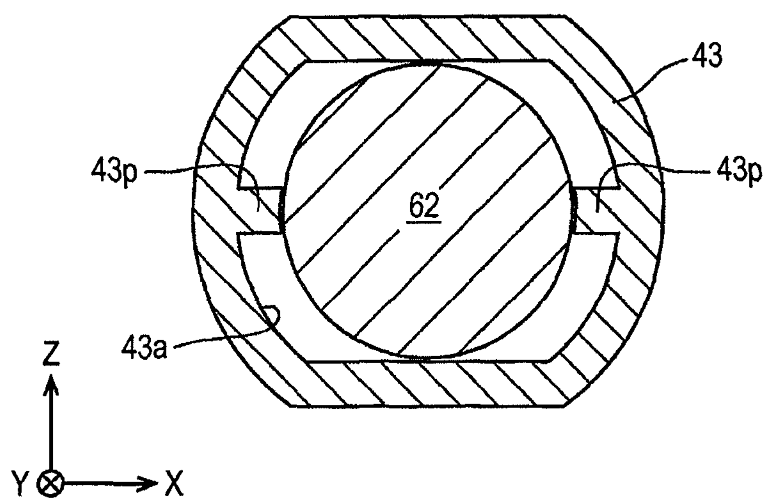


FIG. 7

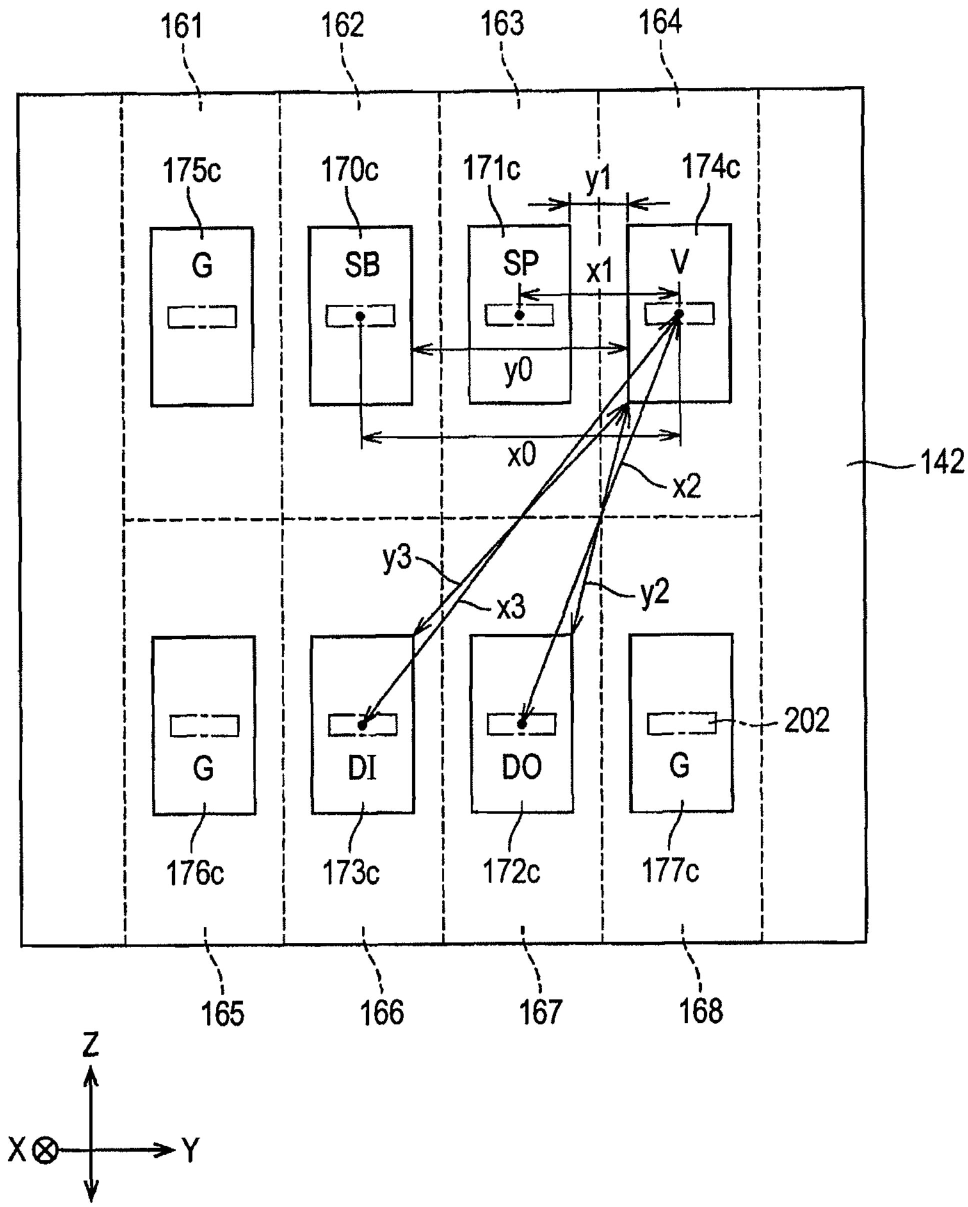

161
162
163
164
175c
170c
171c
y1
174c
G
SB
SP
x1
V
y0
x0
x2
142
y3
x3
y2
202
G
DI
DO
G
176c
173c
172c
177c
165
166
167
168
Z
X
Y

FIG. 8A

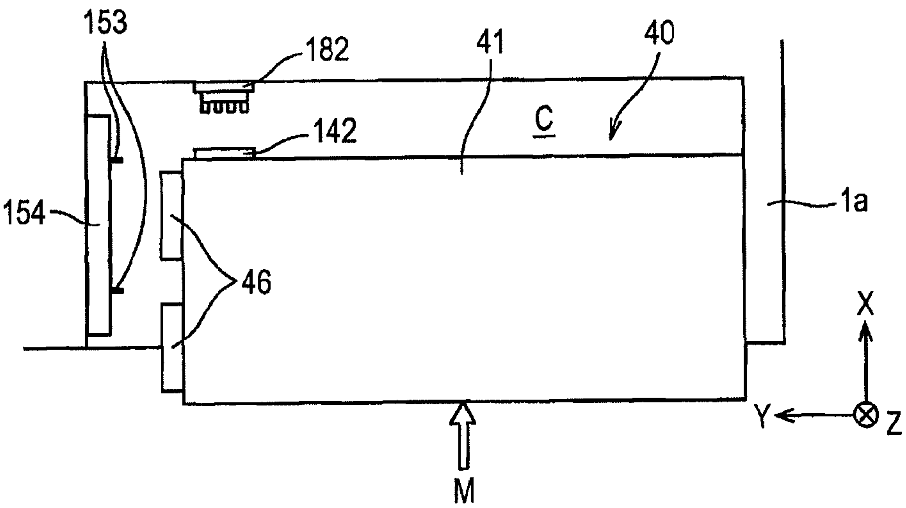


FIG. 8B

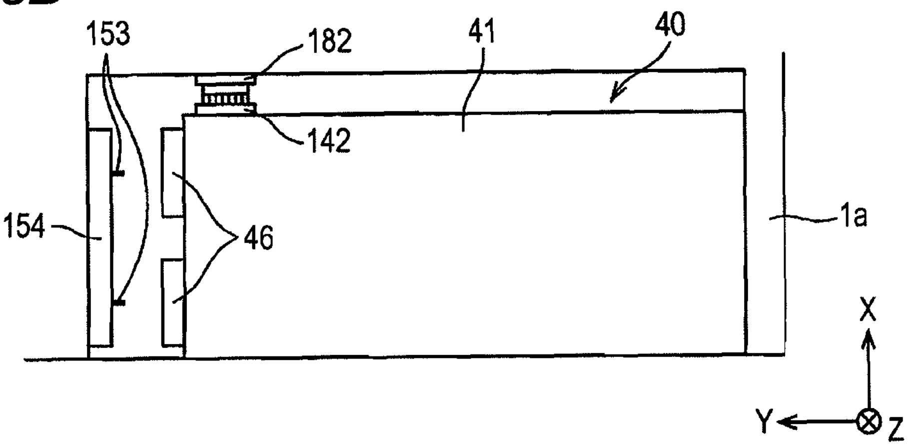


FIG. 8C

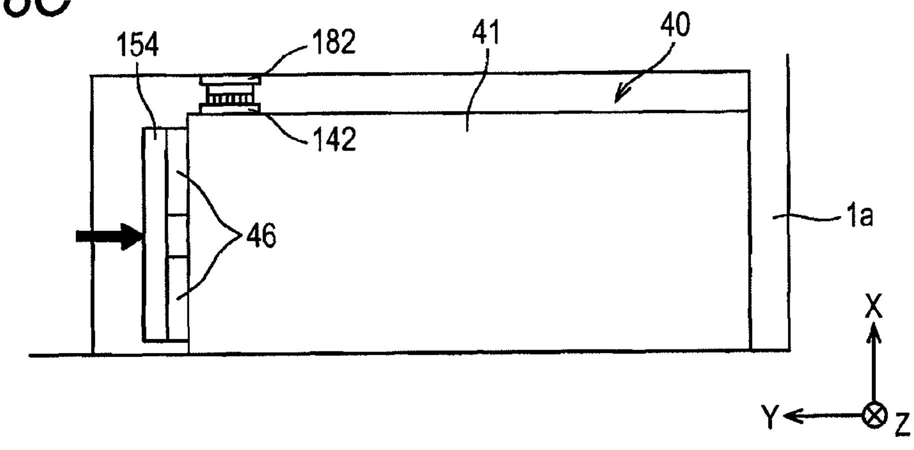


FIG. 9A

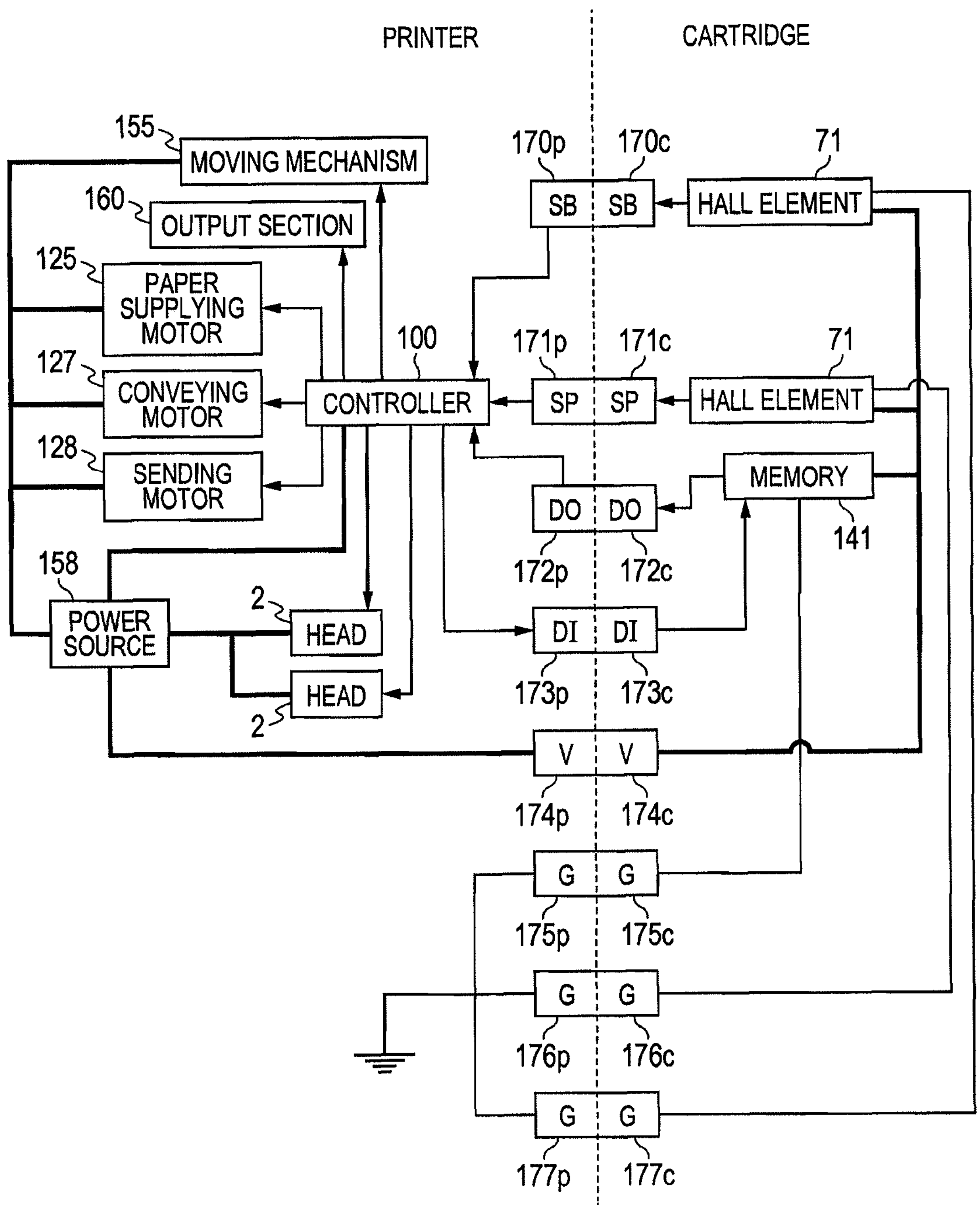
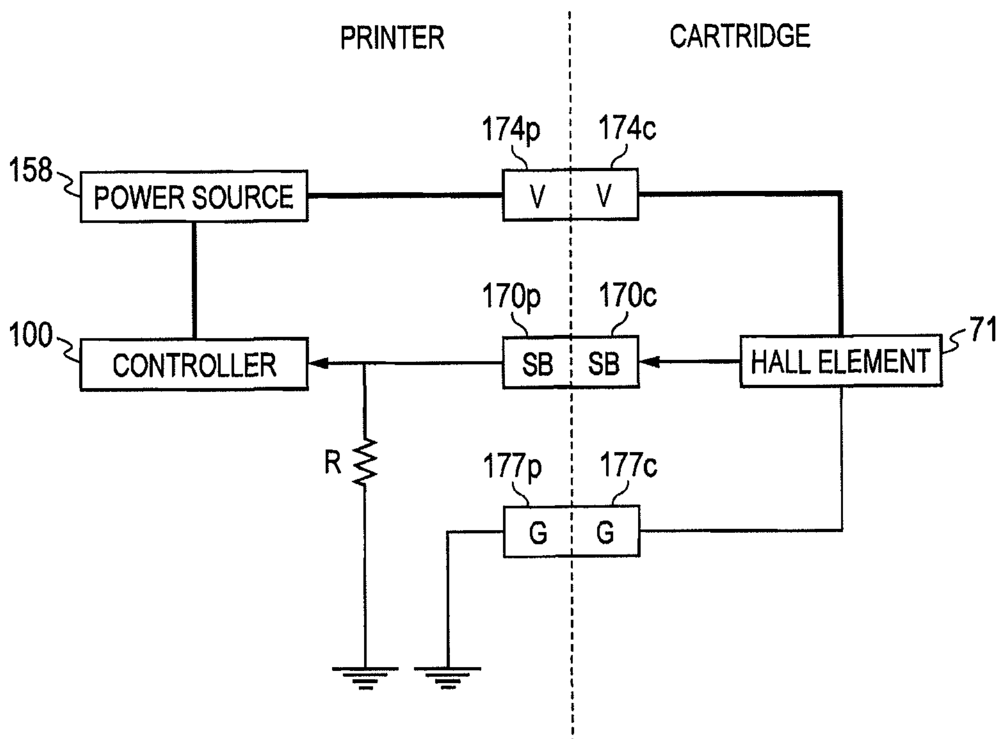

PRINTER
CARTRIDGE
155
MOVING MECHANISM
160
OUTPUT SECTION
125
PAPER SUPPLYING MOTOR
127
CONVEYING MOTOR
128
SENDING MOTOR
158
POWER SOURCE
100
CONTROLLER
2
HEAD
2
HEAD
170p
170c
SB
SB
71
HALL ELEMENT
171p
171c
SP
SP
71
HALL ELEMENT
DO
DO
172p
172c
MEMORY
141
DI
DI
173p
173c
V
V
174p
174c
G
G
175p
175c
G
G
176p
176c
G
G
177p
177c

FIG. 9B


PRINTER
CARTRIDGE
174p
174c
158
POWER SOURCE
V
V
170p
170c
100
CONTROLLER
SB
SB
HALL ELEMENT
71
R
177p
177c
G
G

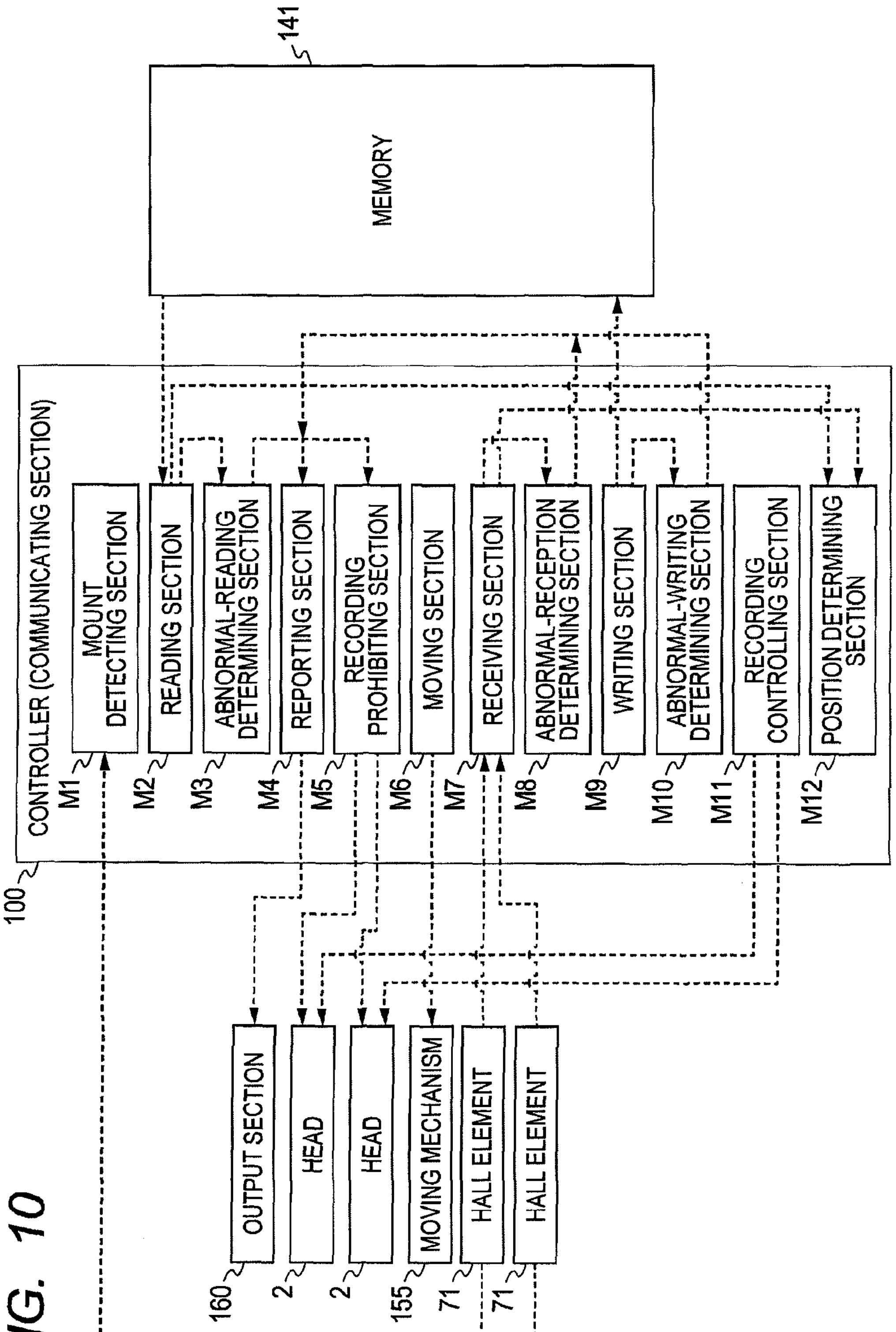

141
MEMORY
100
CONTROLLER (COMMUNICATING SECTION)
M1
MOUNT DETECTING SECTION
M2
READING SECTION
M3
ABNORMAL-READING DETERMINING SECTION
M4
REPORTING SECTION
M5
RECORDING PROHIBITING SECTION
M6
MOVING SECTION
M7
RECEIVING SECTION
M8
ABNORMAL-RECEPTION DETERMINING SECTION
M9
WRITING SECTION
M10
ABNORMAL-WRITING DETERMINING SECTION
M11
RECORDING CONTROLLING SECTION
M12
POSITION DETERMINING SECTION
160
OUTPUT SECTION
2
HEAD
2
HEAD
155
MOVING MECHANISM
71
HALL ELEMENT
71
HALL ELEMENT

FIG. 10

FIG. 11

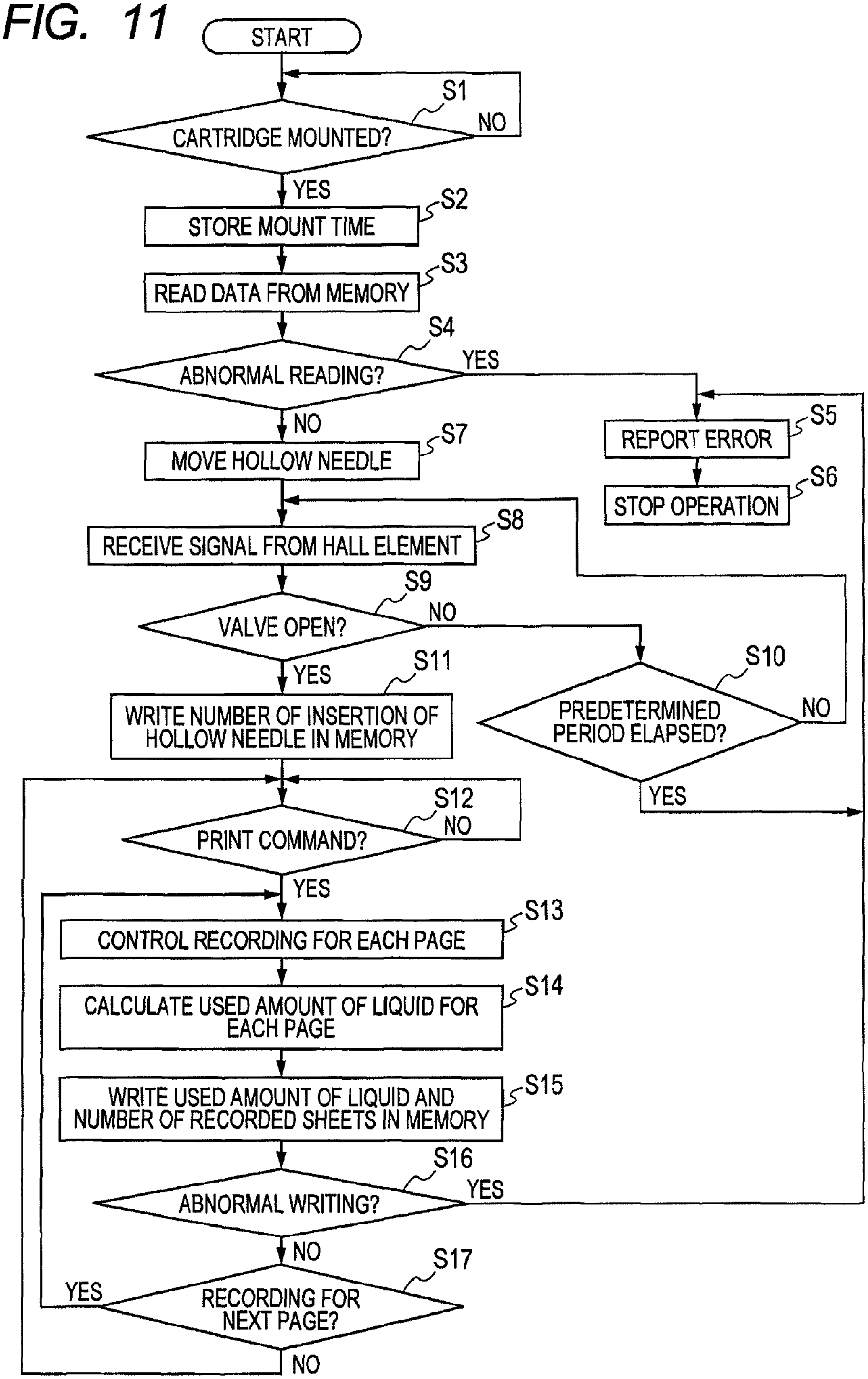

START
CARTRIDGE MOUNTED?
S1
NO
YES
STORE MOUNT TIME
S2
READ DATA FROM MEMORY
S3
ABNORMAL READING?
S4
YES
NO
REPORT ERROR
S5
STOP OPERATION
S6
MOVE HOLLOW NEEDLE
S7
RECEIVE SIGNAL FROM HALL ELEMENT
S8
VALVE OPEN?
S9
NO
YES
PREDETERMINED PERIOD ELAPSED?
S10
NO
YES
WRITE NUMBER OF INSERTION OF HOLLOW NEEDLE IN MEMORY
S11
PRINT COMMAND?
S12
NO
YES
CONTROL RECORDING FOR EACH PAGE
S13
CALCULATE USED AMOUNT OF LIQUID FOR EACH PAGE
S14
WRITE USED AMOUNT OF LIQUID AND NUMBER OF RECORDED SHEETS IN MEMORY
S15
ABNORMAL WRITING?
S16
YES
NO
RECORDING FOR NEXT PAGE?
S17
YES
NO

FIG. 12

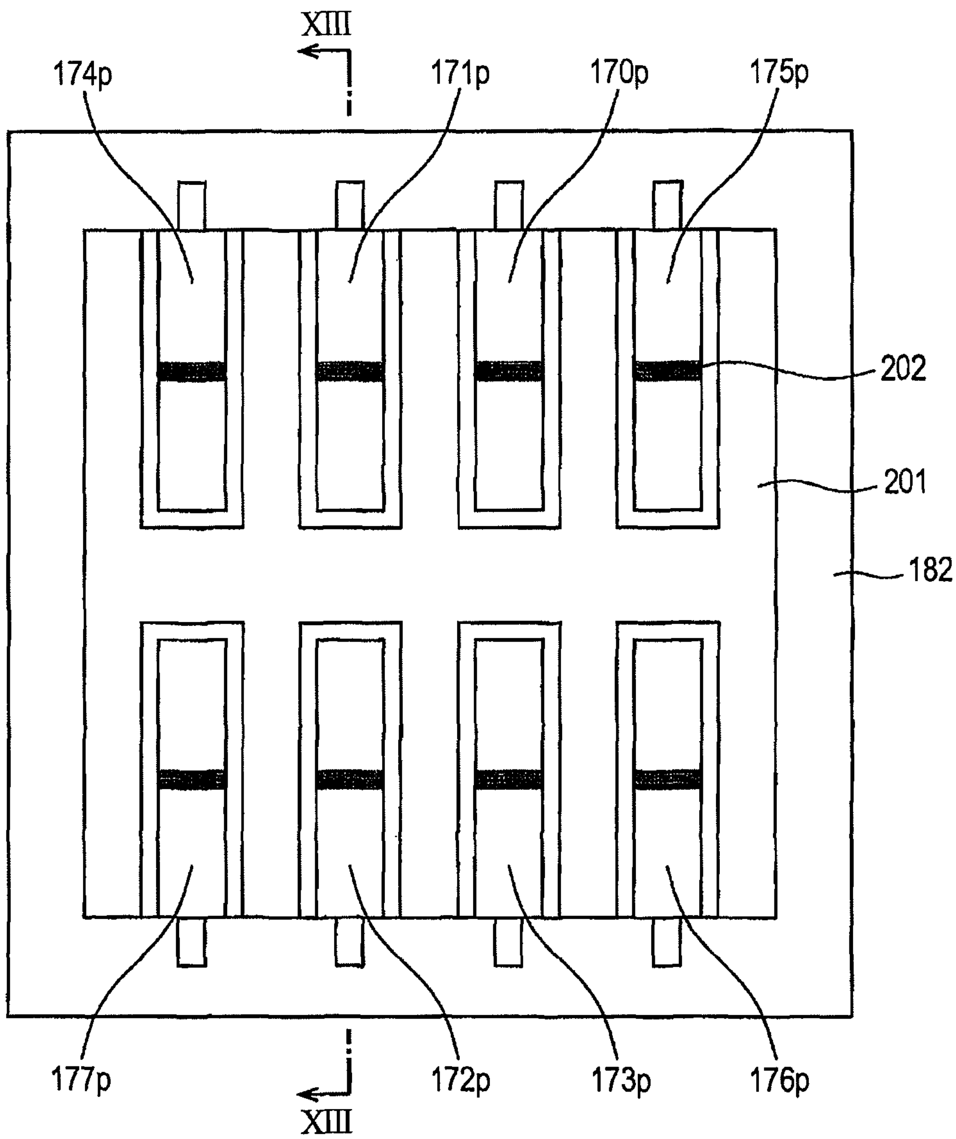


FIG. 13

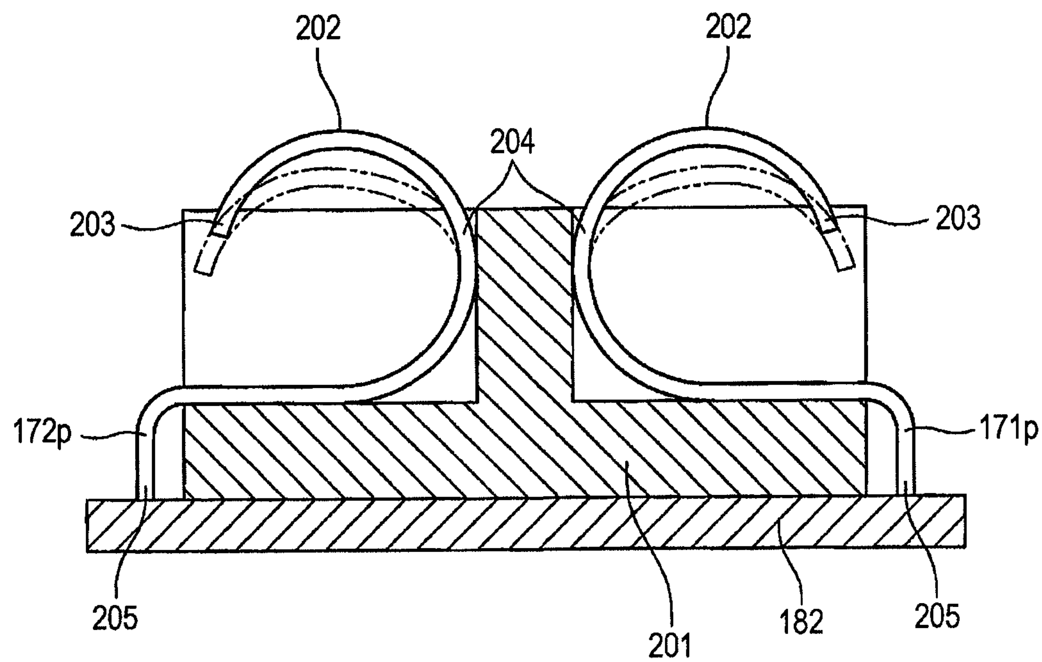


FIG. 14A

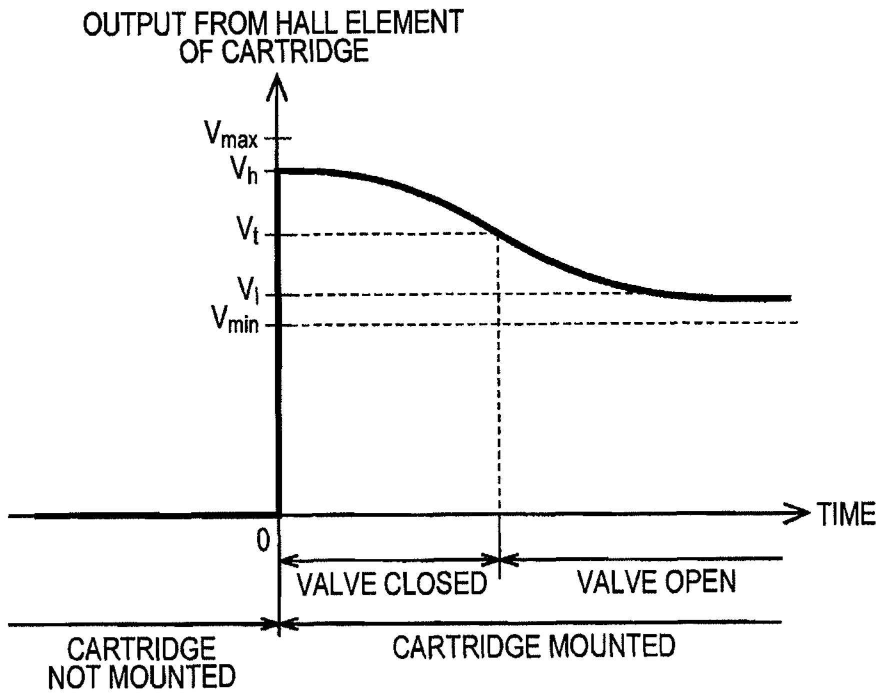


FIG. 14B

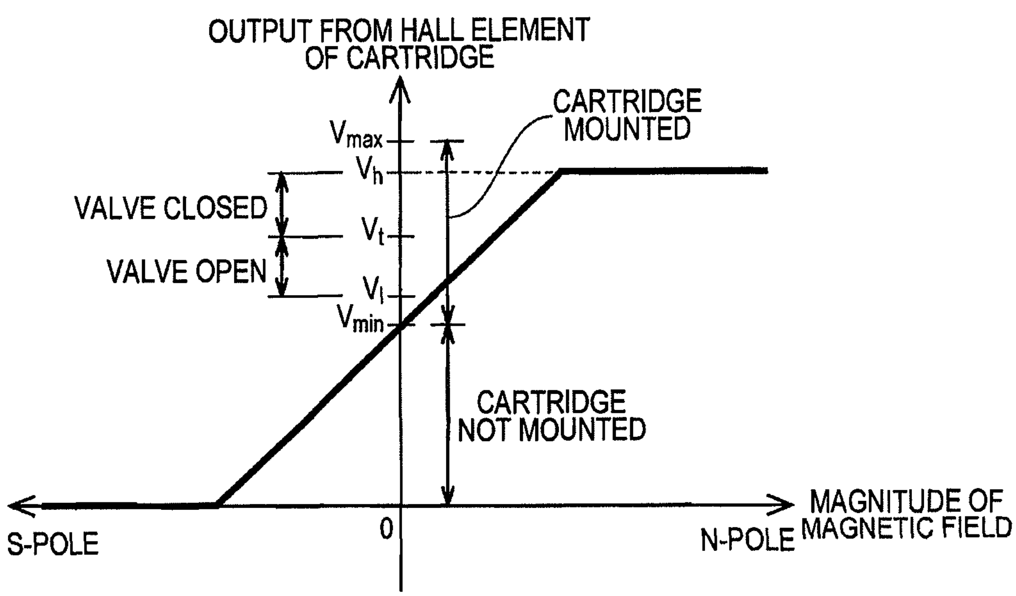


FIG. 15A

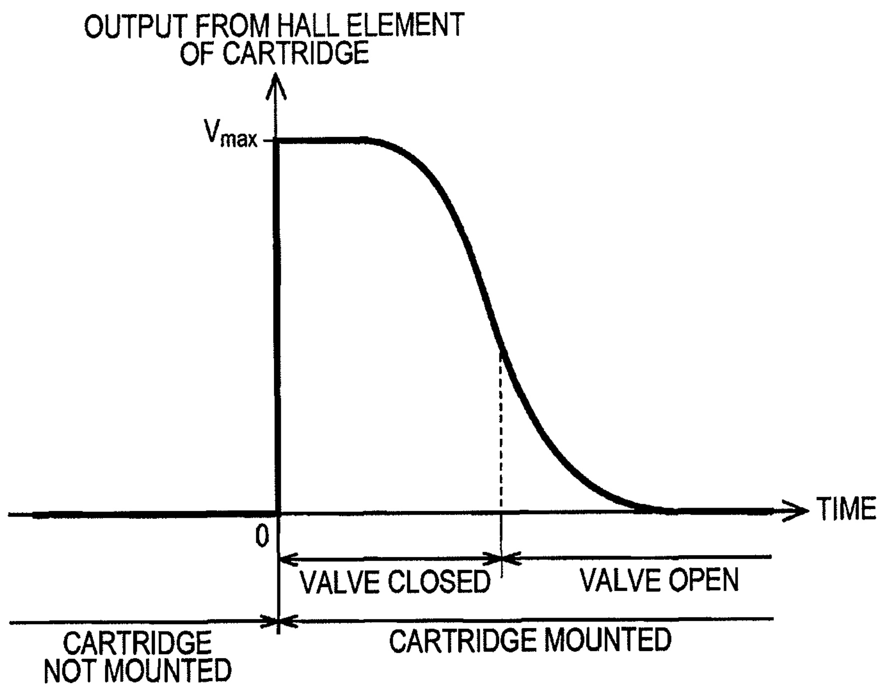


FIG. 15B

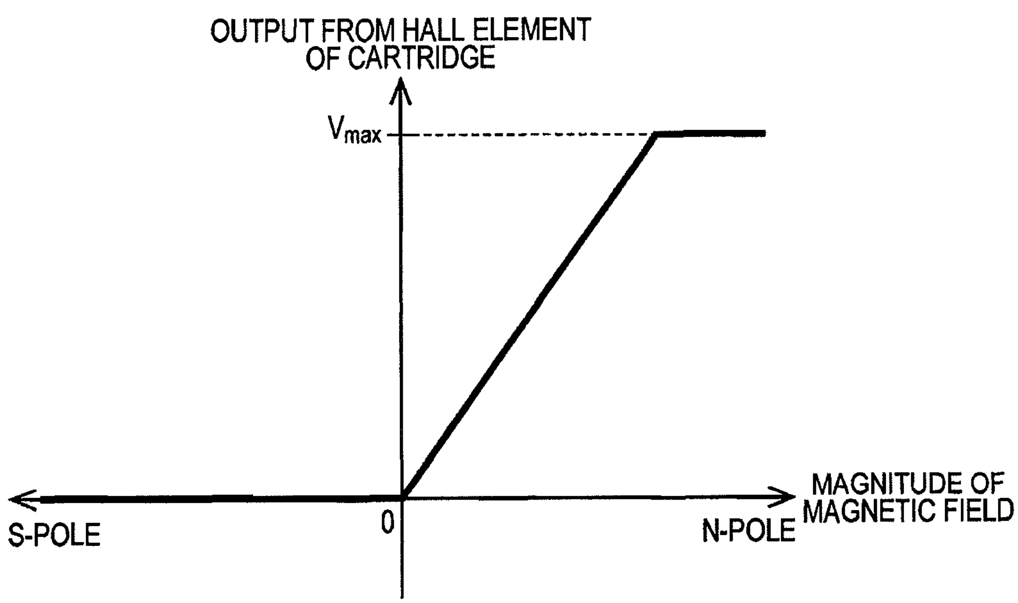


FIG. 16A

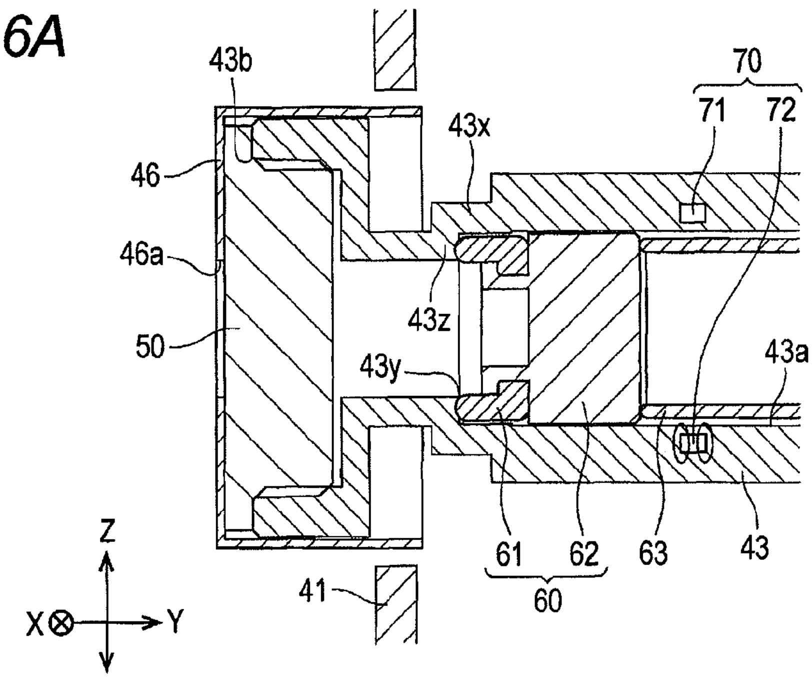


FIG. 16B

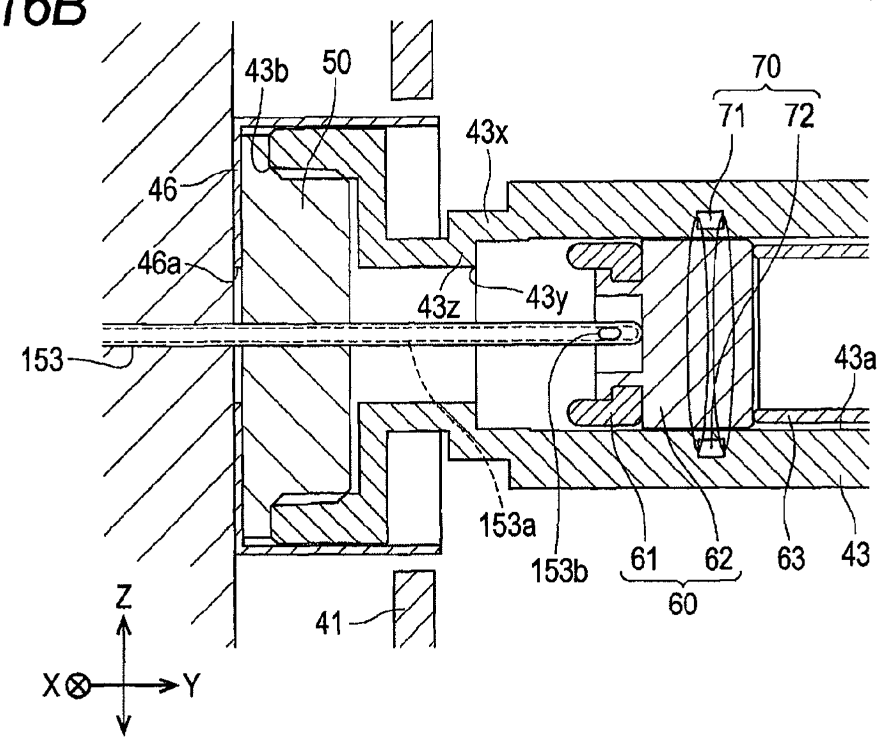


FIG. 17

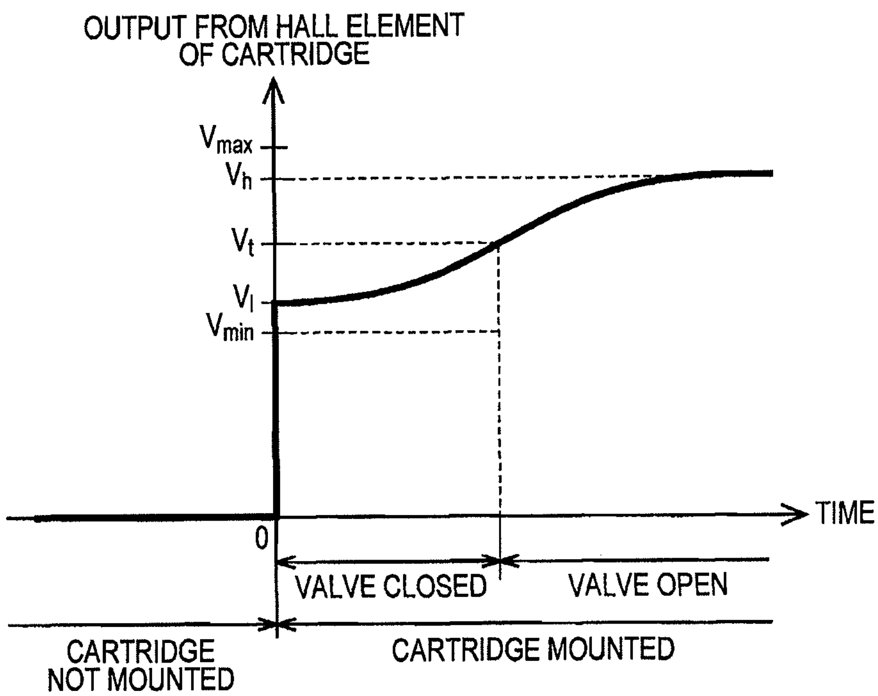

OUTPUT FROM HALL ELEMENT OF CARTRIDGE
V_{max}
V_h
V_t
V_l
V_{min}
0
TIME
VALVE CLOSED
VALVE OPEN
CARTRIDGE NOT MOUNTED
CARTRIDGE MOUNTED

FIG. 18A

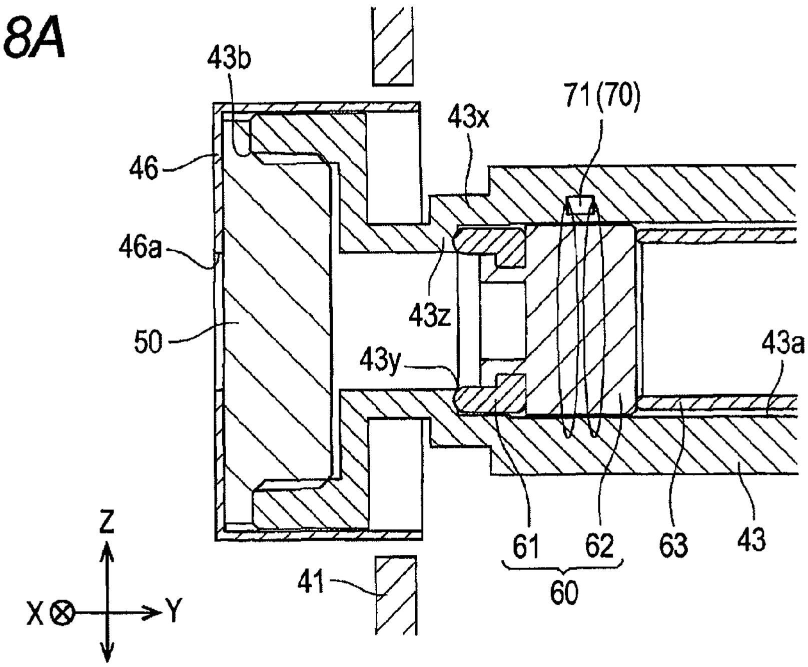


FIG. 18B

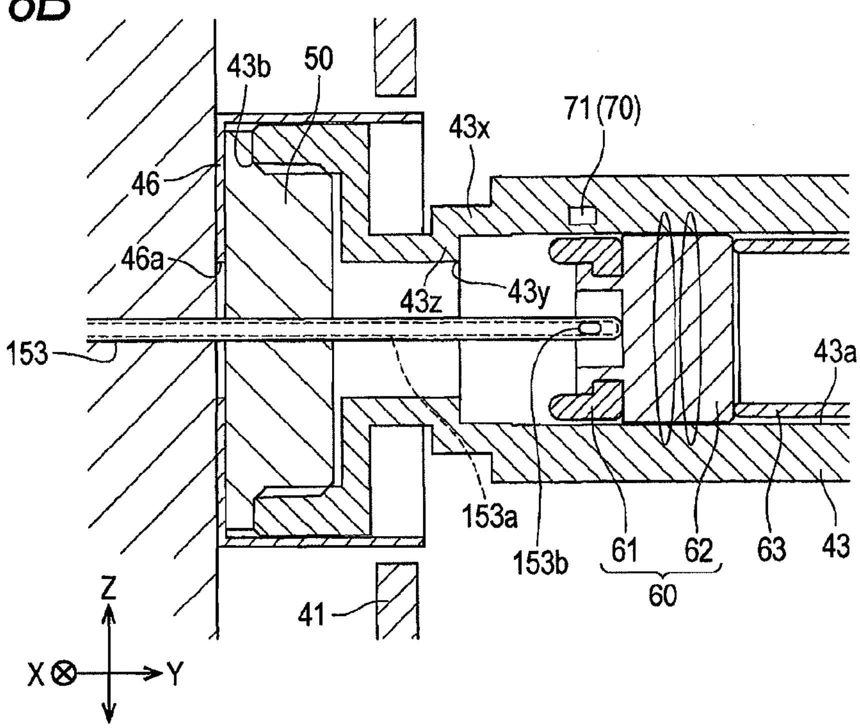


FIG. 19A

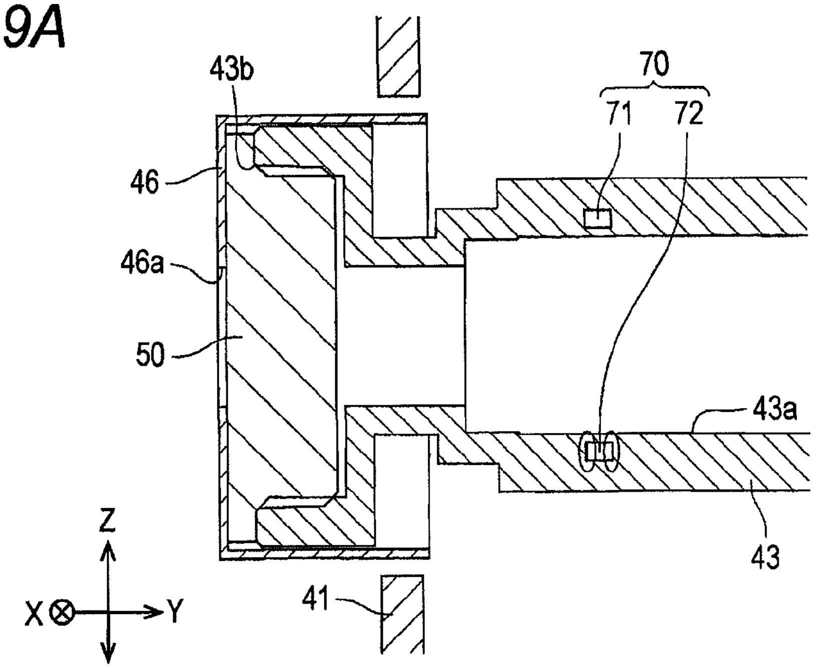


FIG. 19B

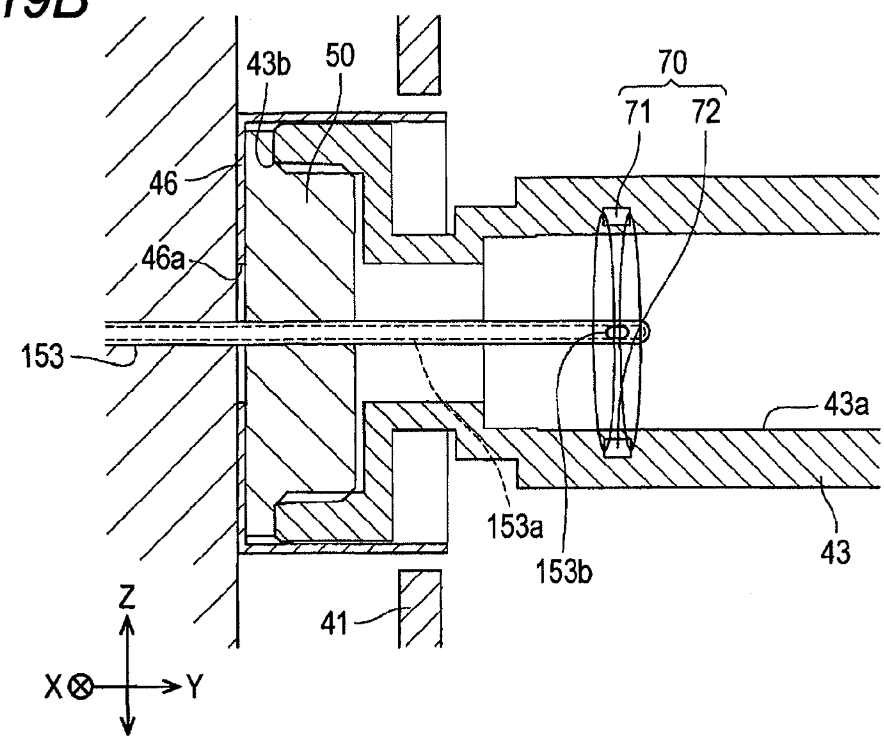


FIG. 20

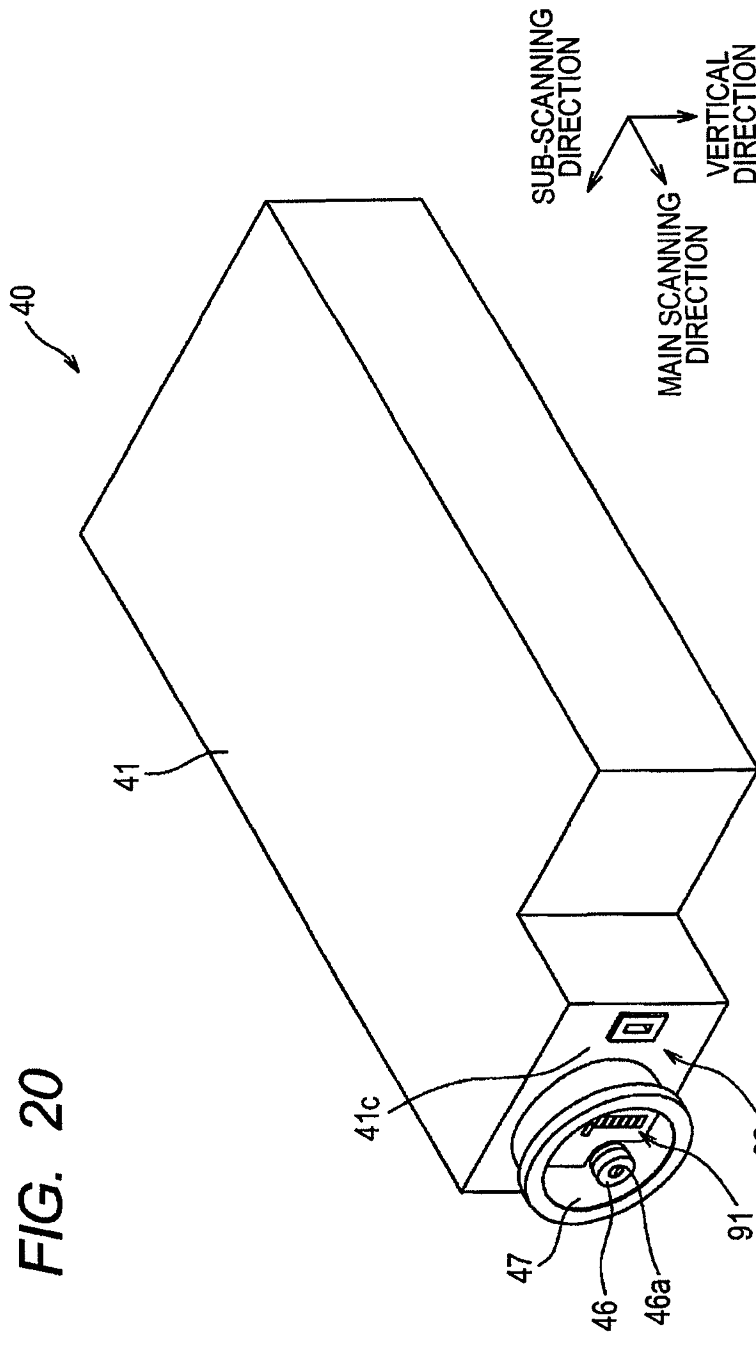

40
41
41c
92
91
47
46
46a
SUB-SCANNING DIRECTION
VERTICAL DIRECTION
MAIN SCANNING DIRECTION

FIG. 21

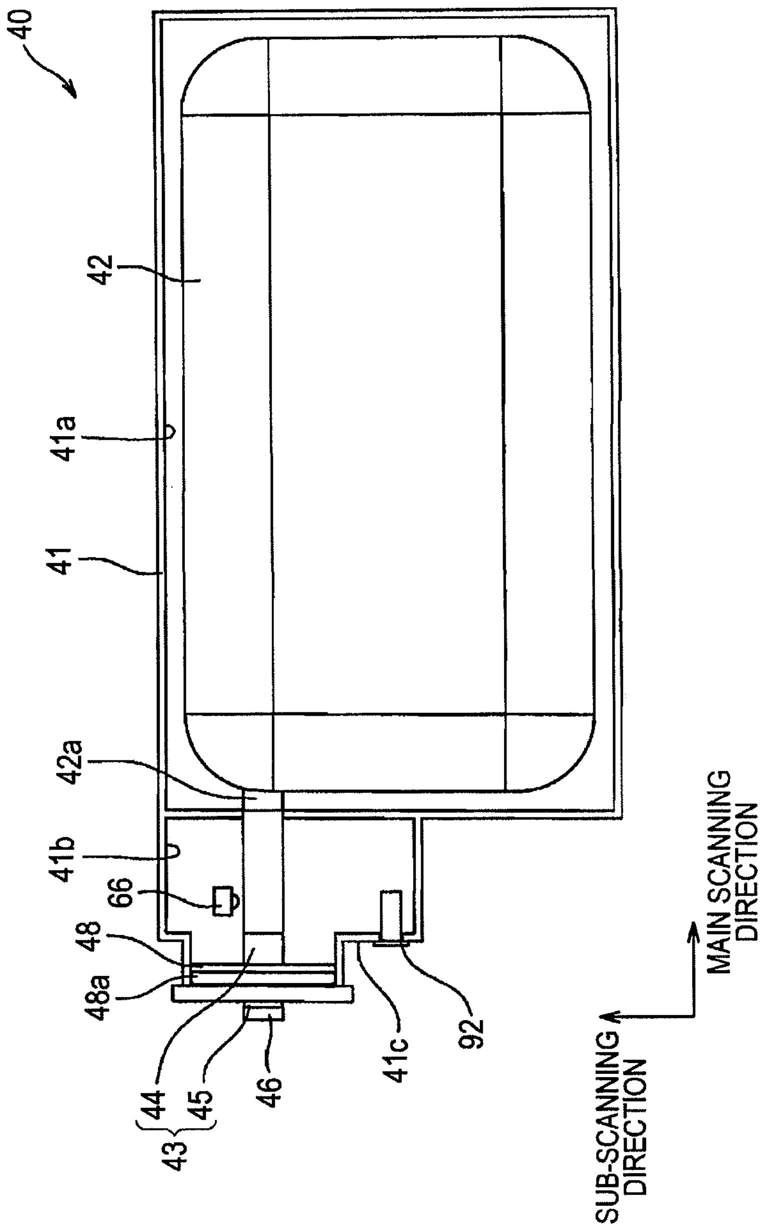

40
42
41a
41
42a
41b
66
48
48a
44
45
46
43
41c
92
MAIN SCANNING DIRECTION
SUB-SCANNING DIRECTION

FIG. 22A

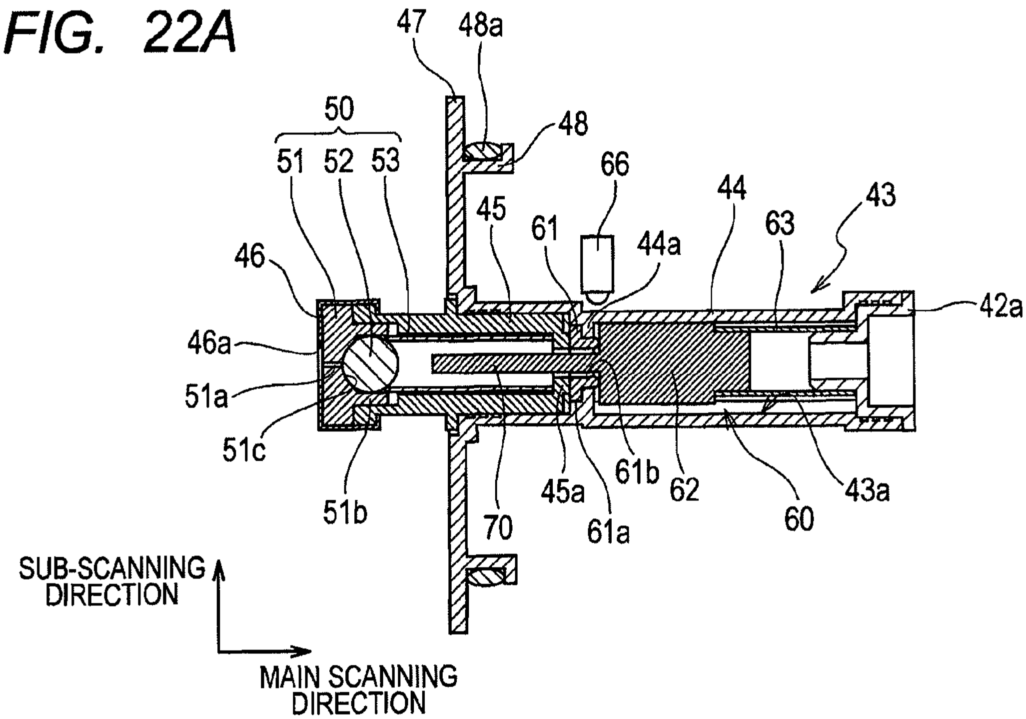
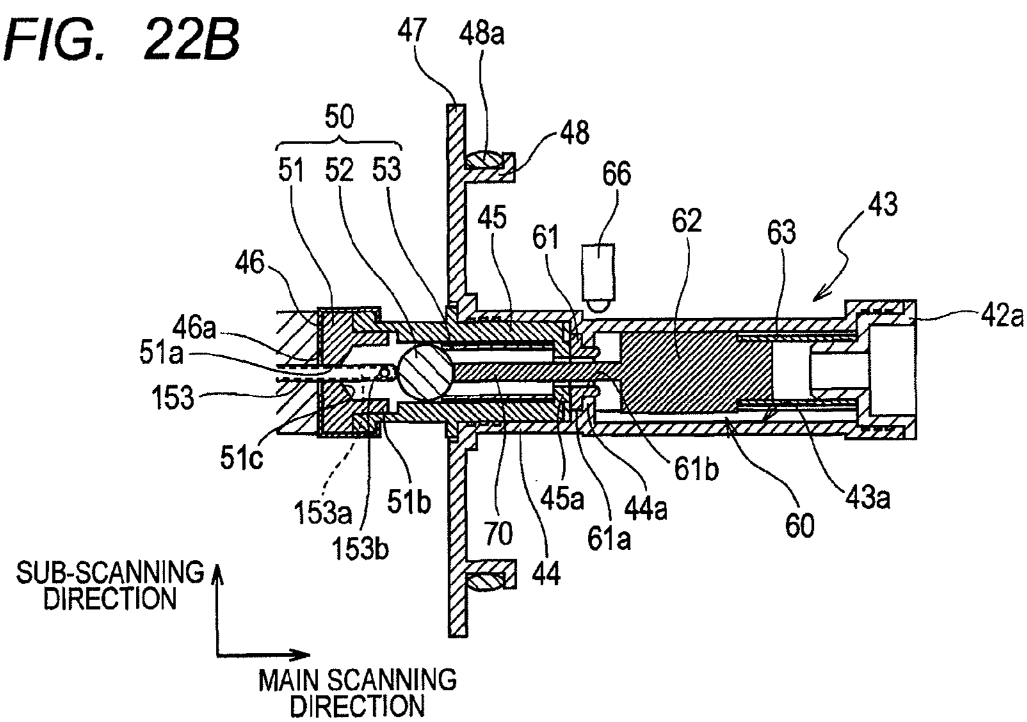


FIG. 22B



LIQUID CARTRIDGE AND LIQUID EJECTING APPARATUS

CROSS REFERENCE TO RELATED APPLICATIONS

This is a Continuation-In-Part Application of International Application No. PCT/JP2011/067255 filed Jul. 28, 2011. The entire disclosure of the prior application is hereby incorporated by reference in its entirety.

TECHNICAL FIELD

The invention relates to a liquid cartridge that stores liquid and to a liquid ejecting apparatus including a liquid cartridge and an apparatus main body on which the liquid cartridge is mounted.

BACKGROUND

According to known technology, an ink remaining-amount sensor is provided at a liquid cartridge mounted on a liquid ejecting apparatus. Further, a cartridge-mounting detection sensor is provided at a liquid cartridge mounted on a liquid ejecting apparatus.

SUMMARY

The inventor of the present application conceived providing, at a liquid cartridge, a plurality of sensors such as the ink remaining-amount sensor, the cartridge-mounting detection sensor, etc. disclosed in the above-mentioned technology.

However, providing a plurality of sensors at the liquid cartridge leads to a cost increase of the liquid cartridge.

In view of the foregoing, the invention provides a liquid cartridge including: a liquid storing section defining a liquid storing chamber that stores liquid; a channel section defining a channel in fluid communication with the liquid storing chamber; a field forming section including a movable member that is movable in the channel and configured to form a field that changes depending on a position of the movable member; a power-source terminal configured such that a power-source potential is inputted thereto; a ground terminal configured such that a ground potential is inputted thereto; a sensor electrically connected with the power-source terminal and the ground terminal, the sensor being configured to generate a potential based on the position of the movable member by being disposed in the field formed by the field forming section; and an output terminal electrically connected with the sensor and configured to output the potential generated by the sensor. The sensor is configured to generate a potential higher than the ground potential regardless of the position of the movable member.

According to another aspect, the invention also provides a liquid ejecting apparatus including a liquid cartridge and an apparatus main body on which the liquid cartridge can be mounted. The liquid cartridge includes: a liquid storing section defining a liquid storing chamber that stores liquid; a channel section defining a channel in fluid communication with the liquid storing chamber; a field forming section including a movable member that is movable in the channel and configured to form a field that changes depending on a position of the movable member; a power-source terminal configured such that a power-source potential is inputted thereto; a ground terminal configured such that a ground potential is inputted thereto; a sensor electrically connected with the power-source terminal and the ground terminal, the

sensor being configured to generate a potential based on the position of the movable member by being disposed in the field formed by the field forming section; and an output terminal electrically connected with the sensor and configured to output the potential generated by the sensor. The apparatus main body includes: a mounting section on which the liquid cartridge is mounted; a hollow member configured to be inserted in the channel of the liquid cartridge mounted on the mounting section; a liquid ejecting head in fluid communication with the hollow member and configured to eject liquid supplied from the liquid cartridge through the hollow member; a power-source potential inputting section configured to input the power-source potential to the power-source terminal; a ground potential inputting section configured to input the ground potential to the ground terminal; a sensor-signal receiving section configured to, when the liquid cartridge is mounted on the mounting section, be connected with the output terminal and receive the potential generated by the sensor; a mount determining section configured to determine whether the liquid cartridge is mounted on the mounting section, based on the potential received by the sensor-signal receiving section; and a position determining section configured to determine the position of the movable member, based on the potential received by the sensor-signal receiving section. The sensor-signal receiving section is configured to receive a predetermined potential when the liquid cartridge is not mounted on the mounting section, and to receive a potential different from the predetermined potential regardless of the position of the movable member when the liquid cartridge is mounted on the mounting section. The mount determining section is configured to determine that the liquid cartridge is not mounted on the mounting section when the potential received by the sensor-signal receiving section is in a first range including the predetermined potential, and to determine that the liquid cartridge is mounted on the mounting section when the potential received by the sensor-signal receiving section is in a second range different from the first range.

BRIEF DESCRIPTION OF THE DRAWINGS

Embodiments in accordance with the invention will be described in detail with reference to the following figures wherein:

FIG. **1** is a perspective view showing the exterior of an inkjet printer according to a first embodiment of the invention;

FIG. **2** is a schematic side cross-sectional view showing the interior of the printer;

FIG. **3** is a perspective view showing the cartridge according to the first embodiment;

FIG. **4** is a schematic view showing the interior of the cartridge;

FIGS. **5**A and **5**B are partial cross-sectional views of a region V shown in FIG. **4**, wherein FIG. **5**A shows a state in which a hollow needle of the printer is not inserted in a plug and a valve is in a closed position, and FIG. **5**B shows a state in which the hollow needle of the printer is inserted in the plug and the valve is in an open position;

FIG. **6** is a partial cross-sectional view taken along a line VI-VI shown in FIG. **5**A;

FIG. **7** is a diagram as viewed from a direction VII shown in FIG. **4**, for illustrating a terminal of the cartridge;

FIGS. **8**A through **8**C are schematic plan views showing a process in which the cartridge is mounted onto the printer, wherein FIG. **8**A shows a state before the cartridge is mounted onto the printer, FIG. **8**B shows a state in which the cartridge is inserted to a position where the terminal of the cartridge contacts a terminal of the printer, and FIG. **8**C shows a state in which a hollow needle supported by a support body has moved in a direction of a filled arrow and penetrated the plug of the cartridge;

FIG. **9**A is a block diagram showing the electrical configuration of the cartridge and the printer;

FIG. **9**B is a block diagram showing a part of the electrical configuration in FIG. **9**A;

FIG. **10** is a functional block diagram showing each functioning section constructed by a controller of the printer;

FIG. **11** is a flowchart showing controls performed by the controller of the printer when the cartridge is mounted on the printer;

FIG. **12** is a diagram as viewed from a mounting direction M shown in FIG. **8**A, for illustrating a terminal of the printer;

FIG. **13** is a partial cross-sectional view taken along a line XIII-XIII shown in FIG. **12**;

FIG. **14**A is a graph showing changes of an output value from a Hall element of the cartridge of the first embodiment in the process in which the cartridge is mounted onto the printer;

FIG. **14**B is a graph showing relationship between magnitude of a magnetic field and the output value from the Hall element in the cartridge of the first embodiment;

FIG. **15**A is a graph showing changes of an output value from a Hall element of a cartridge of a comparative example in a process in which the cartridge is mounted onto the printer;

FIG. **15**B is a graph showing relationship between magnitude of a magnetic field and the output value from the Hall element in the cartridge of the comparative example;

FIGS. **16**A and **16**B are partial cross-sectional views showing a cartridge according to a second embodiment of the invention, and show states in a closed position and in an open position, respectively;

FIG. **17** is a graph showing changes of an output value from a Hall element of the cartridge of the second embodiment in a process in which the cartridge is mounted onto the printer;

FIGS. **18**A and **18**B are partial cross-sectional views showing a cartridge according to a third embodiment of the invention, and show states in a closed position and in an open position, respectively;

FIGS. **19**A and **19**B are partial cross-sectional views showing a cartridge according to a fourth embodiment of the invention, wherein FIG. **19**A shows a state in which a hollow needle of a printer is not inserted into a plug, and FIG. **19**B shows a state in which the hollow needle of the printer is inserted into the plug;

FIG. **20** is a perspective view of an ink cartridge according to a fifth embodiment of the invention;

FIG. **21** is a diagram showing the internal structure of the ink cartridge according to the fifth embodiment; and

FIGS. **22**A and **22**B are partial cross-sectional views of the ink cartridge according to the fifth embodiment, wherein FIG. **22**A shows a state in which two valves are in a closed state, and FIG. **22**B shows a state in which the two valves are in an open state.

DETAILED DESCRIPTION

Hereinafter, embodiments of the invention will be described while referring to the accompanying drawings. First, the overall configuration of an inkjet-type printer **1** according to a first embodiment of a liquid ejecting apparatus of the invention will be described while referring to FIG. **1**.

The printer **1** has a housing **1***a* having a rectangular parallelepiped shape. A paper discharging section **31** is provided on a top plate of the housing **1***a*. Three openings **10***d*, **10***b*, and **10**C are provided on a front surface (the surface on the near left side in the drawing of FIG. **1**) of the housing **1***a* in this order from the top. The opening **10***b* is for inserting a paper supplying unit **1***b* inside the housing **1***a*. The opening **10***c* is for inserting a cartridge unit **1***c* inside the housing **1***a*. The opening **10***d* is fitted with a door **1***d* that can open and close pivotally about a horizontal axis on its lower end. The door **1***d* is disposed in confrontation with a conveying unit **21** (see FIG. **2**) in a main scanning direction X (the direction perpendicular to the front surface of the housing **1***a*) of the housing **1***a*.

Next, the internal structure of the printer **1** will be described with reference to FIG. **2**.

The internal space of the housing **1***a* can be divided into spaces A, B, and C in this order from the top. In the space A, two heads **2**, the conveying unit **21**, and a controller **100** are disposed. The two heads **2** eject black ink and pre-coat liquid (hereinafter, these may be collectively referred to as "liquid"), respectively. The conveying unit **21** conveys paper P. The controller **100** controls operations of each section of the printer **1**. In the spaces B and C, the paper supplying unit **1***b* and the cartridge unit **1***c* are disposed, respectively. Within the printer **1**, a paper conveying path along which paper P is conveyed is formed from the paper supplying unit **1***b* to a paper discharging section **31** along thick arrows in FIG. **2**.

The controller **100** includes a CPU (Central Processing Unit) which is an arithmetic processing unit, a ROM (Read Only Memory), a RAM (Random Access Memory: including non-volatile RAM), I/F (Interface), and the like. The ROM stores programs executed by the CPU, various constant data, and the like. The RAM can temporarily store data (image data etc.) that are required when the programs are executed. The controller **100** performs data transmission and reception with a memory **141** and Hall elements **71** of a cartridge **40**, data transmission and reception with an external device (a personal computer connected with the printer **1** etc.), and the like, via the I/F.

The paper supplying unit **1***b* includes a paper supplying tray **23** and a paper supplying roller **25**. Of these, the paper supplying tray **23** is detachable from the housing **1***a* in the main scanning direction X. The paper supplying tray **23** is a box which is opened upward, and can accommodate paper P in a plurality of sizes. The paper supplying roller **25** rotates by driving of a paper supplying motor **125** (see FIG. **9**A) under controls by the controller **100**, and picks up paper P at the topmost position in the paper supplying tray **23**. The paper P picked up by the paper supplying roller **25** is sent to the conveying unit **21** while being guided by guides **27***a* and **27***b* and being nippingly held by a pair of feed rollers **26**.

The conveying unit **21** includes two belt rollers **6** and **7**, an endless-type conveying belt **8** looped around the both rollers **6** and **7**. The belt roller **7** is a drive roller and, under controls by the controller **100**, rotates in the clockwise direction in FIG. **2** by driving of a conveying motor **127** (see FIG. **9**A) connected with its shaft. The belt roller **6** is a follow roller, and rotates in the clockwise direction in FIG. **2** by following the movement of the conveying belt **8** caused by rotation of the belt roller **7**.

A platen **19** having a rectangular parallelepiped shape is disposed within the loop of the conveying belt **8** so as to confront the two heads **2**. The upper loop of the conveying belt **8** is supported by the platen **19** from the inner peripheral surface side, so that an outer peripheral surface **8***a* of the conveying belt **8** extends parallel to lower surfaces **2***a* (ejecting surfaces in which a large number of ejection ports for ejecting liquid is formed) of the two heads **2** with a predetermined gap therebetween.

A silicone layer with slight adherence is formed on the outer peripheral surface **8***a* of the conveying belt **8**. The paper P sent from the paper supplying unit **1***b* to the conveying unit **21** is pressed against the outer peripheral surface **8***a* of the conveying belt **8** by a pressing roller **4**, and is subsequently conveyed in a sub-scanning direction Y along the thick arrows while being held on the outer peripheral surface **8***a* by adhesive force.

Here, the sub-scanning direction Y is a direction parallel to the conveying direction of paper P by the conveying unit **21**. The main scanning direction X is a direction perpendicular to the sub-scanning direction Y and parallel to a horizontal surface. Each of the main scanning direction X and the sub-scanning direction Y is perpendicular to a vertical direction Z.

When the paper P passes a position directly below each head **2**, the heads **2** are driven under controls by the controller **100** so that liquid (black ink, and pre-coat liquid depending on situations) is ejected toward the top surface of the paper P from the lower surface **2***a* of each head **2**, thereby recording a desired image on the paper P. Then, the paper P is separated from the outer peripheral surface **8***a* of the conveying belt **8** by a separation plate **5**, is conveyed upward while being guided by guides **29***a* and **29***b* and being nippingly held by two pairs of rollers **28**, and is discharged onto the paper discharging section **31** through an opening **30** formed at an upper section of the housing **1***a*. One roller of each pair of rollers **28** rotates by driving of a feed motor **128** (see FIG. **9**A) under controls by the controller **100**.

The pre-coat liquid is liquid having, for example, an effect of improving density (an effect of improving density of ink ejected on paper P), an effect of preventing running of ink and permeation of ink (a phenomenon that ink ejected on the top surface of paper P penetrates the layer of paper P and runs on the bottom surface), an effect of improving chromogenic characteristics and quick drying characteristics, an effect of suppressing wrinkles and curl of paper P subsequent to ejection of ink, and the like. As the pre-coat liquid, for example, liquid containing multivalent metal salt such as cationic polymer, magnesium salt, etc. may be used.

The head **2** that ejects pre-coat liquid is disposed at an upstream side of the head **2** that ejects black ink with respect to the conveying direction of paper P.

The head **2** is a line-type head having substantially a rectangular parallelepiped shape elongated in the main scanning direction X (the direction perpendicular to the drawing sheet of FIG. **2**). The two heads **2** are arranged in the sub-scanning direction Y with a predetermined pitch, and are supported by the housing **1***a* via a frame **3**. A joint to which a flexible tube is attached is provided on the upper surface of each head **2**. A large number of ejection ports is formed on the lower surface **2***a* of each head **2**. A channel is formed inside of each head **2** so that liquid supplied from a corresponding reservoir **42** of the cartridge **40** can reach the ejection ports via the flexible tube and the joint.

The cartridge unit **1***c* includes a tray **35** and one cartridge **40** disposed within the tray **35**. The cartridge **40** includes two reservoirs **42** that accommodate black ink and pre-coat liquid, respectively (see FIG. **4**). Liquid accommodated in each reservoir **42** of the cartridge **40** is supplied to a corresponding one of the heads **2** via the flexible tube and the joint.

The tray **35** is detachable from the housing **1***a* in the main scanning direction X in a state in which the cartridge **40** is disposed inside. Accordingly, a user of the printer **1** can replace the cartridge **40** in the tray **35** in a state in which the tray **35** is removed from the housing **1***a*.

The configuration of the cartridge **40** will be described with reference to FIGS. **3** through **7**.

As shown in FIGS. **3** and **4**, the cartridge **40** includes a housing **41**, a black ink unit **40**B for black ink, a pre-coat liquid unit **40**P for pre-coat liquid, the memory **141**, and a board **142**. Each of the units **40**B and **40**P includes the reservoir **42**, a supply pipe **43**, a plug **50**, a valve **60**, a sensor unit **70**, and the like, and has the same configuration (see FIGS. **4**, **5**A, and **5**B).

As shown in FIG. **3**, the housing **41** has a rectangular parallelepiped shape. As shown in FIG. **4**, the inside of the housing **41** is divided to form two chambers **41***a* and **41***b*. The reservoir **42** of each of the units **40**B and **40**P is disposed in the chamber **41***a* at the right side. The supply pipe **43** of each of the units **40**B and **40**P is disposed in the chamber **41***b* at the left side.

The reservoir **42** is a pouch that stores liquid. The reservoir **42** of the black ink unit **40**B stores black ink, and the reservoir **42** of the pre-coat liquid unit **40**P stores pre-coat liquid. An opening section of the reservoir **42** is connected with a base end of the supply pipe **43**.

The supply pipe **43** defines a supply channel **43***a* (see FIGS. **5**A and **5**B) for supplying the head **2** with liquid stored in the reservoir **42**. As shown in FIG. **4**, a distal end of the supply pipe **43** protrudes outside of the housing **41**. The distal end of the supply pipe **43** is provided with the plug **50** made of elastic material such as rubber in a compressed state, so as to close the opening **43***b* of the supply channel **43***a* at the opposite side from the reservoir **42** (see FIGS. **5**A and **5**B). A cap **46** is provided outside of the distal end of the supply pipe **43** and the plug **50**. An opening **46***a* is formed at the center of the cap **46**, so that a front surface (the surface at the opposite side from a back surface in confrontation with the valve **60**) of the plug **50** is exposed through the opening **46***a*.

As shown in FIGS. **5**A and **5**B, the valve **60** is disposed at the supply channel **43***a* and includes an O-ring **61** and a valve main body **62**.

As shown in FIGS. **5**A, **5**B, and **6**, the valve main body **62** is a magnetic body of a cylindrical shape having an axis in the sub-scanning direction Y.

As shown in FIG. **6**, a portion of the supply pipe **43** at which the valve main body **62** is disposed has a cylindrical shape having flat upper and lower walls and having a cross-section elongated in the main scanning direction X, the cross-section being perpendicular to the sub-scanning direction Y. Each of inner surfaces of the supply pipe **43** at both sides in the main scanning direction X is formed with a protrusion **43***p* that protrudes inward in the main scanning direction X. Each protrusion **43***p* extends in the sub-scanning direction Y over a range in which the valve main body **62** is movable. The valve main body **62** is supported by the protrusions **43***p* and the upper and lower walls of the supply pipe **43**, and is positioned at the center of the supply channel **43***a* in the cross-section. A channel is secured between the valve main body **62** and the supply pipe **43** at portions except contact portions where the valve main body **62** is in contact with the protrusions **43***p* and the upper and lower walls of the supply pipe **43**.

The O-ring **61** is made of elastic material such as rubber, and is fixed to a front surface of the valve main body **62** (the surface that faces the plug **50**).

The valve **60** is urged toward an opening **43***y* by a coil spring **63**. The coil spring **63** has one end fixed to a base end of the supply pipe **43** and another end in contact with a back surface of the valve main body **62**.

As shown in FIG. **5**A, when the valve **60** is in a closed position for closing the supply channel **43***a*, the O-ring **61** is in contact with a portion (valve seat) **43***z* that protrudes from one end (the end closer to the opening **43***b*) of a small diameter portion **43***x* of the supply pipe **43** toward the center of the supply pipe **43** in a radial direction, so that the opening **43**y of one end of the small diameter portion **43**x is sealed. With this arrangement, fluid communication between the reservoir **42** and the outside via the supply channel **43**a is blocked. At this time, the O-ring **61** is deformed elastically by urging force of the coil spring **63**.

The sensor unit **70** includes the Hall element **71** and a magnet **72**. The magnet **72** (magnetic-field generating member) is for generating a magnetic field. The Hall element **71** is a magnetic sensor that converts inputted magnetic field into an electric signal. In the present embodiment, the Hall element **71** generates a potential proportional to magnitude of a magnetic field that changes due to movement of the valve main body **62** (a magnetic body and a movable member) (see FIG. **14**B). The Hall element **71** is disposed in a magnetic field created by the magnet **72** and the valve main body **62** (cooperate to serve as a magnetic-field forming section) (see FIG. **5**A).

As shown in FIG. **5**A, the Hall element **71** and the magnet **72** are fixed to upper and lower walls of the supply pipe **43**, respectively, and confront each other in the vertical direction Z.

As shown in FIG. **5**A, when the valve **60** is in a closed position, the Hall element **71** and the magnet **72** confront each other with the valve main body **62** interposed therebetween. That is, the valve main body **62** is at a position between the Hall element **71** and the magnet **72**. At this time, a magnetic field generated by the magnet **72** reaches the Hall element **71** effectively via the valve main body **62**. Accordingly, the magnetic field detected by the Hall element **71** is strong, and the Hall element **71** generates a high potential.

When the valve **60** moves from the closed position shown in FIG. **5**A to an open position shown in FIG. **5**B where the supply channel **43**a is opened, the valve main body **62** moves to a position that does not confront the Hall element **71** and the magnet **72** (that is, a position not between the Hall element **71** and the magnet **72**) in the vertical direction Z. With this movement, the magnetic field detected by the Hall element **71** becomes weaker, and the potential generated by the Hall element **71** becomes lower.

In this way, the valve main body **62** is linearly movable between an open position where fluid communication between the inside and the outside of the reservoir **42** is allowed and a closed position where fluid communication between the inside and the outside of the reservoir **42** is prohibited. Thus, the open position and the closed position can be switched with a simple configuration of linear movement of the valve main body **62**.

The controller **100** receives a signal of a potential generated by the Hall element **71** through sensor-signal output terminals **170**c and **171**c and, based on the potential, determines whether the cartridge **40** is mounted at a predetermined position in the space C and whether the position of the valve **60** is the open position or the closed position. Detailed descriptions will be provided later in terms of potentials generated by the Hall element **71** (output values from the Hall element **71**) and the specific method of the above-described determination by the controller **100** based on the potentials.

As shown in FIG. **4**, the board **142** is provided on an outer surface of a side wall of the housing **41** at the downstream side in a mounting direction M of the cartridge **40** into the space C (hereinafter, simply referred to as "mounting direction M"). In the present embodiment, the mounting direction M is a direction in parallel with the main scanning direction X.

The memory **141** is disposed at the back side of the board **142**. The memory **141** is an EEPROM or the like, and stores data relating to the cartridge **40**. Specifically, the memory **141** preliminarily stores data such as a liquid amount (an amount of liquid within each reservoir **42** in a brand-new cartridge **40**), sensor output values (output values Vh and Vl from each Hall element **71**; see FIGS. **14**A and **14**B), and a manufacturing date (date, month, and year on which the cartridge **40** is manufactured). The sensor output values are stored in the memory **141** at the time of manufacture or recycling of the cartridge **40**, as data unique to the cartridge **40**. Further, when the cartridge **40** is mounted on the printer **1**, the controller **100** can write, in the memory **141**, data relating to a used amount of liquid (a used amount of liquid within each reservoir **42**, that is, an amount of liquid ejected from each head **2**), a number of insertion of hollow needle (a number by which a hollow needle **153** is inserted in the plug **50**), a number of recorded sheets (a number of sheets of paper P on which recording is performed with liquid within the cartridge **40**), a cumulative usage period (a time period during which the cartridge **40** is mounted on the printer **1**, and is the same as a time period during which the hollow needle **153** is inserted in the supply channel **43**a), and the like. When the cartridge **40** is mounted on the printer **1**, the controller **100** can also read data stored in the memory **141**.

As shown in FIG. **7**, eight terminals **170**c through **177**c are provided on a surface of the board **142**. All of the terminals **170**c through **177**c have the same size and shape, and are exposed on an outer surface of the cartridge **40**. Each of the terminals **170**c through **177**c has a rectangular shape with two short sides parallel to the sub-scanning direction Y and two long sides parallel to the vertical direction Z. The terminals **170**c through **177**c are arranged in two rows.

Center-to-center distances x0-x3 between each terminal **170**c-**173**c and the terminal **174**c have relationship of $x1<x0<x2<x3$. Shortest distances y0-y3 between outer edges of each terminal **170**c-**173**c and the terminal **174**c have relationship of $y1<y0<y2<y3$. Here, xn (n=0-3) denotes a center-to-center distance between a terminal **17**nc and the terminal **174**c, and yn (n=0-3) denotes a shortest distance between the outer edges of the terminal **17**nc and the terminal **174**c.

As shown in FIG. **9**A, a sensor-signal output terminal (SB) **170**c is electrically connected with the Hall element **71** of the black ink unit **40**B. A sensor-signal output terminal (SP) **171**c is electrically connected with the Hall element **71** of the pre-coat liquid unit **40**P. A data output terminal (DO) **172**c and a data input terminal (DI) **173**c are electrically connected with the memory **141**. A power-source terminal (V) **174**c is electrically connected with the two Hall elements **71** and the memory **141**. Three ground terminals (G) **175**c, **176**c, and **177**c are electrically connected with the memory **141**, the Hall element **71** of the pre-coat liquid unit **40**P, and the Hall element **71** of the black ink unit **40**B, respectively.

As shown in FIGS. **8**A through **8**C, a board **182** is provided on a wall surface perpendicular to the mounting direction M (the main scanning direction X), the wall surface being one of wall surfaces defining the space C of the housing **1**a. The board **182** has substantially the same size as the board **142**, and is disposed at a position confronting the board **142** when the cartridge **40** is mounted to a predetermined position in the space C (see FIG. **8**B). As shown in FIGS. **12** and **13**, a base material **201** is provided on a surface of the board **182**. Eight terminals **170**p through **177**p corresponding to eight terminals **170**c through **177**c, respectively, are provided on the base material **201**.

As shown in FIG. **13**, each of the terminals **170**p through **177**p includes a leaf spring having substantially a C-shape in cross-section. One end **205** of each of the terminals **170**p through **177**p is a fixed end that is fixed to the board **182**, and is electrically connected with the board **182**. Another end **203** of each of the terminals **170**_p_ through **177**_p_ is a free end that can bend with a part **204** as a fulcrum. The another end **203** is urged upward in FIG. **13** (that is, the direction approaching the terminals **170**_c_ through **177**_c_ of the cartridge **40** mounted at the predetermined position in the space C).

The terminals **170**_p_ through **177**_p_ are arranged in a mirror symmetry pattern with the pattern of the terminals **170**_c_ through **177**_c_ shown in FIG. **7**, so as to make contact with the terminals **170**_c_ through **177**_c_, respectively, when the cartridge **40** is mounted at the predetermined position in the space C. Each of the terminals **170**_p_ through **177**_p_ is arranged so that each top portion **202** makes contact with the center of a corresponding one of the terminals **170**_c_ through **177**_c_.

As shown in FIG. **9**A, a sensor-signal receiving terminal (SB) **170**_p_, a sensor-signal receiving terminal (SP) **171**_p_, a data receiving terminal (DO) **172**_p_, and a data transmitting terminal (DI) **173**_p_ are electrically connected with the controller **100**. A power-source potential input terminal (V) **174**_p_ is electrically connected with a power source **158**. Three ground-potential input terminals (G) **175**_p_, **176**_p_, and **177**_p_ are connected with ground. The power source **158** is provided in the housing **1**_a_.

Here, a potential received by the controller **100** from the Hall element **71** will be described while referring to FIG. **9**B. FIG. **9**B is a diagram schematically showing a part of the electrical configuration in FIG. **9**A. Note that, although the Hall element **71** for black ink will be described here, the same goes for the Hall element **71** for pre-coat liquid. As shown in FIG. **9**B, the controller **100** is connected with ground via a resistance R (not shown in FIG. **9**A). Hence, in a state where the cartridge **40** is not mounted on the printer **1** (a state where the circuit is cut off in the vertical dotted line in the center of FIG. **9**B), a ground potential is inputted to the controller **100**. On the other hand, in a state where the cartridge **40** is mounted on the printer **1**, an output potential of the Hall element **71** (a sensor signal) is inputted to the controller **100** via the sensor-signal output terminal **170**_c_ and the sensor-signal receiving terminal **170**_p_.

Next, a process in which the cartridge **40** is mounted to the printer **1** will be described with reference to FIGS. **5**A through **14**B. In FIGS. **8**A through **8**C, illustration of the tray **35** is omitted. In FIGS. **9**A and **9**B, power supply lines are indicated by thick lines, and signal lines are indicated by thin lines.

Before the cartridge **40** is mounted to the printer **1**, in each of the units **40**B and **40**P, the hollow needle **153** is not inserted in the plug **50**, and the valve **60** is held in a closed position (see FIG. **5**A). At this stage, electrical connection between the terminals **170**_c_ through **177**_c_ and the terminals **170**_p_ through **177**_p_, respectively, are not achieved. Accordingly, the Hall elements **71** and the memory **141** are not supplied with electrical power, and the controller **100** cannot perform transmission and reception of signals with the Hall elements **71** and the memory **141**.

When the cartridge **40** is mounted to the printer **1**, the user of the printer **1** moves the tray **35** in the mounting direction M (the direction indicated by a blanked arrow in FIG. **8**A) in a state where the cartridge **40** is placed in the tray **35** (see FIG. **2**), thereby inserting the cartridge **40** into the space C of the housing **1**_a_. At this time, as shown in FIG. **8**B, the cartridge **40** is inserted to a position at which the terminals **170**_c_ through **177**_c_ and the terminals **170**_p_ through **177**_p_ are in contact with each other.

At the stage of FIG. **8**B, the centers of the terminals **170**_c_ through **177**_c_ make contact with the top portions **202** of the terminals **170**_p_ through **177**_p_, respectively, so as to achieve electrical connection between the terminals **170**_c_ through **177**_c_ and the terminals **170**_p_ through **177**_p_. With this operation, a power-source potential is inputted to the power-source terminal **174**_c_, and electrical power is supplied to the Hall element **71** and the memory **141**. At this time, a ground potential is inputted to the ground terminals **175**_c_ through **177**_c_. The controller **100** can then perform reception of signals from the Hall element **71** of the black ink unit **40**B via the terminals **170**_c_ and **170**_p_, reception of signals from the Hall element **71** of the pre-coat liquid unit **40**P via the terminals **171**_c_ and **171**_p_, reading of data from the memory **141** via the terminals **172**_c_ and **172**_p_, and writing of data to the memory **141** via the terminals **173**_c_ and **173**_p_.

In a process in which the cartridge **40** is mounted to the printer **1**, immediately before mounting is completely finished, the centers of the terminals **170**_c_ through **177**_c_ make contact with the top portions **202** of the terminals **170**_p_ through **177**_p_. Subsequently, before mounting is completely finished, the terminals **170**_p_ through **177**_p_ are pressed by the terminals **170**_c_ through **177**_c_ so that the another end **203** bends downward with the part **204** as the fulcrum, thereby shifting from a state shown by solid lines in FIG. **13** to a state shown by double-dot chain lines. The top portions **202** of the terminals **170**_p_ through **177**_p_ contact the terminals **170**_c_ through **177**_c_ in contact regions (regions surrounded by single-dot chain lines in FIG. **7**) including the centers of the terminals **170**_c_ through **177**_c_ when mounting is completely finished. From a state immediately before mounting is completely finished to a state when mounting is completely finished, the contact regions of the top portions **202** on the terminals in the upper row (the terminals **175**_c_, **170**_c_, **171**_c_, and **174**_c_) slide upward gradually from positions slightly below the regions surrounded by single-dot chain lines in FIG. **7**, whereas the contact regions of the top portions **202** on the terminals in the lower row (the terminals **176**_c_, **173**_c_, **172**_c_, and **177**_c_) slide downward gradually from positions slightly above the regions surrounded by single-dot chain lines in FIG. **7**.

A support body **154** is disposed on a wall surface perpendicular to the sub-scanning direction Y and confronting the two caps **46** when the cartridge **40** is mounted to the predetermined position in the space C, the wall surface being one of wall surfaces defining the space C of the housing **1**_a_. The support body **154** supports the two hollow needle **153** and is movable in the sub-scanning direction Y relative to the housing **1**_a_. The two hollow needles **153** correspond to the head **2** that ejects black ink and the head **2** that ejects pre-coat liquid, respectively, and are in fluid communication with the flexible tube attached to the joint of the corresponding head **2**.

At the stage of FIG. **8**B, the cartridge **40** is separated from the hollow needles **153**, and each reservoir **42** is not in fluid communication with the channel of the corresponding head **2**.

The controller **100** determines whether the cartridge **40** is mounted at the predetermined position in the space C, based on an output value from the Hall element **71** (S**1** in FIG. **11**).

Here, changes of the output value from the Hall element **71**, in a process where the cartridge **40** is mounted to the printer **1**, will be described while referring to FIG. **14**A. In FIG. **14**A, the horizontal axis indicates time, and the vertical axis indicates output values from the Hall element **71**. It is assumed that time 0 is a time point at which the cartridge **40** is mounted at the predetermined position in the space C.

Before the cartridge **40** is mounted at the predetermined position in the space C (when the cartridge is not mounted at the predetermined position in the space C), the output value from the Hall element **71** is kept at a ground potential (0V) (see a “cartridge not mounted” range shown in FIG. **14**A). When the cartridge **40** is mounted at the predetermined position in the space C to achieve electrical connection between the terminals **170**c through **177**c and the terminals **170**p through **177**p, the output value from the Hall element **71** increases from the ground potential to Vh. After that, in a process where the valve **60** moves from the closed position to the open position, the output value from the Hall element **71** gradually decreases from Vh to Vl (see a "cartridge mounted" range shown in FIG. **14**A). During a period in which the cartridge **40** is mounted at the predetermined position in the space C, the output value from the Hall element **71** is higher than the ground potential and lower than the power-source potential (Vmax) ($0<Vmin<Vl\leq V\leq Vh<Vmax$), regardless of the position of the valve **60**.

If the output value V from the Hall element **71** is higher than or equal to Vmin and lower than Vmax ($Vmin\leq V<Vmax$), the controller **100** determines that the cartridge **40** is mounted at the predetermined position in the space C (S**1**: YES). If the output value V from the Hall element **71** is lower than Vmin ($V<Vmin$), the controller **100** determines that the cartridge **40** is not mounted at the predetermined position in the space C (S**1**: NO).

The values of Vmax and Vmin are stored in the ROM of the controller **100**. In S**1**, the controller **100** receives signals from the Hall element **71** of each unit **40**B, **40**P, reads out the values of Vmax and Vmin from the ROM, and makes the above-described determination based on these values and the output value from the Hall element **71**.

Note that there are two Hall elements **71** in the present embodiment. Hence, the controller **100** determines that the cartridge **40** is mounted at the predetermined position in the space C when the above-described mounting condition ($Vmin\leq V<Vmax$) is satisfied for both of the two Hall elements **71**. Otherwise (for example, in a case where the mounting condition is satisfied for one of the Hall elements **71** but the mounting condition is not satisfied for the other one of the Hall elements **71**, etc.), the controller **100** determines that the cartridge **40** is not mounted at the predetermined position in the space C.

If the controller **100** determines that the cartridge **40** is mounted at the predetermined position in the space C as described above (S**1**: YES), the controller **100** stores time at that time (mount time) in the RAM of the controller **100** (S**2**). Subsequent to S**2**, the controller **100** reads data stored in the memory **141** of the cartridge **40** (data relating to the liquid amount, the sensor output value, the manufacturing date, the used amount of liquid, the number of insertion of hollow needle, the number of recorded sheets, the cumulative usage period, and the like) (S**3**).

Subsequent to S**3**, the controller **100** determines whether reading in S**3** is abnormal (S**4**). If reading is not performed normally in S**3**, the controller **100** determines that reading in S**3** is abnormal (S**4**: YES) and uses an output section **160** (see FIG. **9**A) such as a display, a speaker, etc. of the printer **1** to report an error (S**5**). Subsequent to S**5**, the controller **100** stops operations of each section of the printer **1** (S**6**).

If reading is abnormal, it is presumed that the memory **141** is damaged by short circuit between the terminal **172**c and the terminal **174**c, or that a failure occurs with communication function of the controller **100** by short circuit between the terminal **173**c and the terminal **174**c.

If reading is performed normally in S**3**, the controller **100** determines that reading is not abnormal (S**4**: NO) and controls a moving mechanism **155** (see FIG. **9**A) to move the support body **154** together with the two hollow needles **153** supported by the support body **154** in the sub-scanning direction Y (the direction indicated by a filled arrow in FIG. **8**C) (S**7**).

With movement of the hollow needle **153** in S**7**, as shown in FIG. **5**B, in each of the units **40**B and **40**P, first, the hollow needle **153** penetrates a substantial center of the plug **50** via the opening **46**a in the sub-scanning direction Y.

At this time, an opening **153**b formed at the distal end of the hollow needle **153** is located in the supply channel **43**a, so that a channel **153**a in the hollow needle **153** and the supply channel **43**a are in fluid communication with each other via the opening **153**b. Although a hole is formed in the plug **50** by the hollow needle **153** at this time, a portion of the plug **50** around the hole closely contacts the outer circumferential surface of the hollow needle **153** by elasticity. This suppresses liquid leakage from between the hole in the plug **50** and the hollow needle **153**.

Subsequently, the distal end of the hollow needle **153** abuts the valve main body **62**. Then, further penetration of the hollow needle **153** into the supply channel **43**a causes the valve main body **62** to move together with the O-ring **61** and causes the O-ring **61** to separate from the valve seat **43**z (see FIG. **5**B). At this time, the position of the valve **60** changes from a closed position to an open position.

When the valve **60** is in the open position, fluid communication between the reservoir **42** and the outside is allowed via the supply channel **43**a. That is, as shown in FIG. **5**B, when the plug **50** is penetrated by the hollow needle **153** and the valve **60** is in the open position, the reservoir **42** is in fluid communication with the channel of the head **2** via the supply channel **43**a, the channel **153**a, and the like.

Subsequent to S**7**, the controller **100** receives a signal from the Hall element **71** of each of the units **40**B and **40**P (S**8**). Subsequent to S**8**, the controller **100** determines whether the valve **60** is disposed at the open position in each of the units **40**B and **40**P (that is, whether fluid communication is formed between the reservoir **42** and the head **2** so that liquid is supplied from the reservoir **42** to the head **2** via the hollow needle **153**), based on the output values Vh and Vl read from the memory **141** in S**3** and on the signal received in S**8** (S**9**). In the present embodiment, determination in S**9** is performed as described below.

That is, as shown in FIG. **14**A, the controller **100** determines that the valve **60** is in the open position (S**9**: YES) if the output value V from the Hall element **71** received in S**8** is lower than or equal to a threshold value Vt ($V\leq Vt$) calculated based on the output values Vh and Vl read in S**3** (for example, $Vt=(Vh+Vl)/2$), and determines that the valve **60** is in the closed position (S**9**: NO) if the output value V from the Hall element **71** exceeds the threshold value Vt ($Vt<V$).

As shown in FIG. **14**B, the Hall element **71** of the present embodiment generates a potential higher than the ground potential ($V=Vmin>0$) when the Hall element **71** is disposed in a magnetic field of magnitude 0.

If a predetermined period elapses while the valve **60** of each of the units **40**B and **40**P is not disposed in the open position (S**10**: YES), the controller **100** reports an error (S**5**) and stops operations of each section of the printer **1** (S**6**).

In this case, it is presumed that the Hall element **71** of the black ink unit **40**B is damaged by short circuit between the terminal **170**c and the terminal **174**c, that the Hall element **71** of the pre-coat liquid unit **40**P is damaged by short circuit between the terminal **171**c and the terminal **174**c, that a failure occurs with communication function of the controller **100** by short circuit between the terminal **173**c and the terminal **174**c, or that a failure occurs with the plug **50**, the valve **60**, the hollow needle **153** and the moving mechanism **155** of the printer **1**, etc.

If the controller **100** determines that the valve **60** of each of the units **40**B and **40**P is disposed in the open position (S**9**:

YES), the controller **100** writes, in the memory **141**, data indicative of a value obtained by adding one to the number of insertion of hollow needle read in S**3** (S**11**). Subsequent to S**11**, the controller **100** determines whether a print command from an external device has been received (S**12**).

If a print command is received (S**12**: YES), the controller **100** controls driving of a paper supplying motor **125**, a conveying motor **127**, the feed motor **128**, the head **2**, and the like to perform recording for each page of paper P (S**13**). Subsequent to S**13**, the controller **100** calculates the used amount of liquid for each page of paper P (that is, the amount of each liquid of black ink and pre-coat liquid ejected for one page of the paper P that is recorded this time) (S**14**).

Subsequent to S**14**, the controller **100** writes, in the memory **141**, data indicative of the used amount of each liquid (the amount of liquid in each reservoir **42** that has been used since the cartridge **40** is a brand-new cartridge, that is, a value obtained by adding the used amount of liquid for each page calculated in S**14** to the used amount of liquid read in S**3**) and the number of recorded sheets (the number of sheets of paper P on which recording has been performed with the cartridge **40** since the cartridge **40** is a brand-new cartridge, that is, a value obtained by adding one to the number of recorded sheets read in S**3**) (S**15**).

Subsequent to S**15**, the controller **100** determines whether writing in S**15** is abnormal (S**16**). If writing is not performed normally in S**15**, the controller **100** determines that writing in S**15** is abnormal (S**16**: YES), reports an error (S**5**), and stops operations of each section of the printer **1** (S**6**).

If writing is abnormal, it is presumed that the memory **141** is damaged by short circuit between the terminal **172***c* and the terminal **174***c*, or that a failure occurs with communication function of the controller **100** by short circuit between the terminal **173***c* and the terminal **174***c*.

If writing is performed normally in S**15**, the controller **100** determines that writing is not abnormal (S**16**: NO), and determines whether there are recording data for the next page, based on image data included in the print command received in S**12** (S**17**).

If there are recording data for the next page (S**17**: YES), the controller **100** returns to S**13** and repeats the above-described series of steps S**13** through S**16**. On the other hand, if there are no recording data for the next page (S**17**: NO), the controller **100** returns to S**12** and waits until a print command is received again.

Note that the printer **1** includes a lock mechanism (not shown) for locking the cartridge **40**. If the controller **100** determines that the cartridge **40** is mounted at the predetermined position in the space C (S**1**: YES), the controller **100** drives the lock mechanism concurrently with the process in S**2**, for example, to lock the cartridge **40** together with the tray **35** at the predetermined position.

In order to dismount the cartridge **40** from the printer **1**, the user of the printer **1** presses a lock release button. If the controller **100** detects pressing of the lock release button, the controller **100** first controls the moving mechanism **155** (see FIG. **9**A) to move the support body **154** in the direction opposite from the filled arrow in FIG. **8**C so that the support body **154** returns from the position of FIG. **8**C to the position of FIG. **8**B. At this time, in each of the units **40**B and **40**P, as the hollow needle **153** moves in the leftward direction in FIG. **5**B, urging force of the coil spring **63** causes the valve **60** to move in the leftward direction in FIG. **5**B to make contact with the valve seat **43***z*. With this operation, the position of the valve **60** shifts from the open position to the closed position. The controller **100** determines that the valve **60** is in the closed position when the output value from the Hall element **71** exceeds the threshold value Vt in each of the units **40**B and **40**P and, based on that time (dismount time) and mount time stored in S**2**, calculates the cumulative usage period (a time period from the mount time until the dismount time). The controller **100** writes, in the memory **141**, data indicative of a value obtained by adding the cumulative usage period read in S**3** to the calculated cumulative usage period (that is, the value is the cumulative usage period during which the cartridge **40** is mounted on the printer **1** since the cartridge **40** is a brand-new cartridge). Subsequently, the hollow needle **153** is pulled out of the plug **50**. At this time, a hole formed in the plug **50** by the hollow needle **153** becomes small to an extent that liquid leakage is suppressed, due to elasticity of a portion of the plug **50** around the hole.

Subsequently, the controller **100** drives the lock mechanism to unlock the cartridge **40**. With this operation, the user can pull the tray **35** out of the space C. When the tray **35** is pulled out of the space C, the board **142** separates from the board **182**. Thus, electrical connections between the terminals **170***c* through **177***c* and the terminals **170***p* through **177***p* are disconnected, which stops power supply to the Hall elements **71** and the memory **141** and which prevents the controller **100** from performing transmission and reception of signals with the Hall elements **71** and the memory **141**.

The controller **100** displays a value obtained by subtracting the used amount of liquid written in the memory **141** in S**15** from the liquid amount read in S**3**, as the remaining amount of each liquid, on the display of the printer **1**.

As shown in FIG. **10**, the controller **100** serves as a communication section that communicates with the cartridge **40** mounted in the space C, and also serves as each functioning section corresponding to processes in FIG. **11**. A mount detecting section M**1** corresponds to S**1**, a reading section M**2** corresponds to S**3**, an abnormal-reading determining section M**3** corresponds to S**4**, a reporting section M**4** corresponds to S**5**, a recording prohibiting section M**5** corresponds to S**6**, a moving section M**6** corresponds to S**7**, a receiving section M**7** corresponds to S**8**, an abnormal-reception determining section M**8** corresponds to S**9** and S**10**, a writing section M**9** corresponds to S**11** and S**15**, an abnormal-writing determining section M**10** corresponds to S**16**, a recording controlling section M**11** corresponds to S**13**, and a position determining section M**12** corresponds to S**9**.

As described above, according to the first embodiment, in order to determine whether the cartridge **40** is mounted at the predetermined position in the space C (S**1** in FIG. **11**), reliability in mounting determination can be secured while utilizing the Hall element **71** that is provided for a different purpose from the mounting determination (a purpose of determining the position of the valve **60** in the present embodiment). That is, it is determined whether the cartridge **40** is mounted at the predetermined position in the apparatus main body, by utilizing the sensor (the Hall element **71** in the present embodiment) configured to generate a potential based on a position of the movable member that is movable in the supply channel **43***a* (the valve main body **62** in the present embodiment). Hence, a cost increase of the cartridge **40** can be suppressed. Further, even if the sensor generates a potential that is not generated at normal times, due to movement malfunction of the movable member, no erroneous determination is made, thereby improving reliability in determination.

Specifically, for example, in a configuration where the output value from the Hall element **71** changes as shown in FIG. **15**A (comparative example), when the cartridge **40** is mounted at the predetermined position in the space C, there are a case where the output value from the Hall element **71** is higher than the ground potential (mainly, a closed state of the valve) and a case where the output value from the Hall element **71** is the same as the ground potential (mainly, an open state of the valve). When the cartridge **40** is not mounted at the predetermined position in the space C, the output value from the Hall element **71** (actually, the potential inputted to the controller **100**) is the same as the ground potential (see FIG. **9**B). That is, potentials that can be generated by the Hall element **71** when the cartridge **40** is mounted at the predetermined position in the space C include a potential that is inputted to the controller **100** when the cartridge **40** is not mounted at the predetermined position in the space C.

Note that, in a state where the cartridge **40** is not mounted at the predetermined position in the space C, the printer **1** and the cartridge **40** are not electrically connected with each other, and thus the output value from the Hall element **71** is not inputted to the controller **100**. In FIGS. **14**A, **15**A, and **17**, it is labeled "Output from Hall element of cartridge" for convenience, even in a state where the cartridge is not mounted.

In this configuration, if the cartridge **40** is mounted in the space C while the valve **60** remains at the open position (for example, in a case where a once-mounted cartridge **40** is mounted again, a failure occurs, such as that the valve **60** is stuck in the supply channel **43***a* when returning from the open position to the closed position, and the failure remains unresolved), the Hall element **71** outputs a potential that is the same as the ground potential. The ground potential is a potential that is inputted to the controller **100** when the cartridge **40** is not mounted at the predetermined position in the space C. Hence, in this case, although the cartridge **40** is mounted at the predetermined position in the space C, the controller **100** determines that the cartridge is not mounted.

On the other hand, in the present embodiment, as shown in FIG. **14**A, the output value from the Hall element **71** is always higher than the ground potential when the cartridge **40** is mounted at the predetermined position in the space C, and the potential inputted to the controller **100** is the same as the ground potential when the cartridge **40** is not mounted at the predetermined position in the space C. That is, the potentials that can be generated by the Hall element **71** when the cartridge **40** is mounted at the predetermined position in the space C do not include the potential that is inputted to the controller **100** when the cartridge **40** is not mounted at the predetermined position in the space C. In other words, the potential that can be generated by the Hall element **71** when the cartridge **40** is mounted at the predetermined position in the space C is distinguishable from the potential that is inputted to the controller **100** when the cartridge **40** is not mounted at the predetermined position in the space C.

In the present embodiment, even if the cartridge **40** is mounted in the space C while the valve **60** remains at the open position, the Hall element **71** does not output a potential that is the same as the ground potential (the potential that is inputted to the controller **100** when the cartridge **40** is not mounted at the predetermined position in the space C). Accordingly, the controller **100** does not determine that the cartridge **40** is not mounted at the predetermined position in the space C despite a fact that the cartridge **40** is mounted at the predetermined position in the space C. That is, the above-described error in mounting determination can be suppressed, and reliability in mounting determination can be secured.

As in the comparative example shown in FIG. **15**B, in a case where such a Hall element is adopted that, when disposed in a magnetic field of magnitude 0, generates a potential that is the same as a ground potential, in order to satisfy a condition that "the output value from the Hall element is higher than the ground potential regardless of the position of the valve **60**", a moving range of the valve **60** needs to be set such that the moving range does not include a position at which a magnetic field becomes magnitude 0.

On the other hand, in the present embodiment, as shown in FIG. **14**B, such a Hall element **71** is adopted that, when disposed in a magnetic field of magnitude 0, generates a potential that is higher than a ground potential ($V=V_{min}>0$). Hence, without making a special arrangement as described above, the condition is satisfied that "the output value from the Hall element **71** is higher than the ground potential regardless of the position of the valve **60**". That is, the degree of freedom of design improves.

There are cases that the power-source potential input terminal **174***p* and the sensor-signal receiving terminal **170***p*, **171***p* are short-circuited, and that the controller **100** receives a power-source potential from the sensor-signal receiving terminal **170***p*, **171***p*. The controller **100** recognizes the potential received from the sensor-signal receiving terminal **170***p*, **171***p* as the potential outputted from the sensor-signal output terminal **170***c*, **171***c* (that is, the potential generated by the Hall element **71**).

For example, in a configuration where the output value from the Hall element **71** changes as shown in FIG. **15**A, if a power-source potential is received from the sensor-signal receiving terminal **170***p*, **171***p* due to the above-described short-circuit, the controller **100** determines that the cartridge **40** is mounted at the predetermined position in the space C although the cartridge **40** is not mounted. This is because the power-source potential (Vmax) is a potential that can be generated by the Hall element **71** when the cartridge **40** is mounted at the predetermined position in the space C.

On the other hand, in the present embodiment, as shown in FIG. **14**A, when the cartridge **40** is mounted at the predetermined position in the space C, the output value from the Hall element **71** is always lower than the power-source potential (Vmax). The controller **100** determines that the cartridge **40** is mounted at the predetermined position in the space C if the output value V from the Hall element **71** is higher than or equal to Vmin and lower than Vmax ($V_{min} \leq V < V_{max}$). Hence, if the power-source potential is received from the sensor-signal receiving terminal **170***p*, **171***p* due to the above-described short-circuit, the controller **100** does not determine that the cartridge **40** is mounted at the predetermined position in the space C despite a fact that the cartridge **40** is not mounted at the predetermined position in the space C. This is because the power-source potential (Vmax) is a potential outside a range in which it is determined that the cartridge **40** is mounted at the predetermined position in the space C. That is, the above-described error in mounting determination can be suppressed, and reliability in mounting determination can be secured more reliably.

The power-source terminal **174***c*, the ground terminals **175***c* through **177***c*, and the sensor-signal output terminals **170***c* and **171***c* are arranged on the same plane. With this arrangement, electrical connection between the power-source terminal **174***c* and the power-source potential input terminal **174***p*, electrical connection between the ground terminals **175***c* through **177***c* and the ground-potential input terminals **175***p* through **177***p*, and electrical connection between the sensor-signal output terminals **170***c*, **171***c* and the sensor-signal receiving terminals **170***p*, **171***p* can be performed substantially at the same time. Thus, reliability in mounting determination can be secured even more reliably.

Next, second through fourth embodiments of the invention will be described while referring to FIGS. **16**A through **19**B, wherein like parts and components are designated by the same reference numerals to avoid duplicating descriptions.

First, the second embodiment of the invention will be described while referring to FIGS. **16**A, **16**B, and **17**. The second embodiment has substantially the same configuration as the first embodiment, except the positions of the Hall element **71** and the magnet **72** and the process S**9** in FIG. **11**.

As can be seen from comparison between FIGS. **16**A, **16**B and FIGS. **5**A, **5**B, the Hall element **71** and the magnet **72** in the second embodiment are located at positions further spaced away from the plug **50** in the sub-scanning direction Y, than in the first embodiment.

As shown in FIG. **16**A, when the valve **60** is at the closed position, the Hall element **71** and the magnet **72** do not confront the valve main body **62** in the vertical direction Z. That is, the valve main body **62** is located at a position not between the Hall element **71** and the magnet **72**. At this time, the magnetic field detected by the Hall element **71** is weak, and the Hall element **71** generates a low potential.

When the valve **60** moves from the closed position shown in FIG. **16**A to the open position shown in FIG. **16**B, the valve main body **62** moves to a position confronting the Hall element **71** and the magnet **72** in the vertical direction Z (that is, a position between the Hall element **71** and the magnet **72**). With this movement, the magnetic field generated by the magnet **72** reaches the Hall element **71** efficiently via the valve main body **62**. Accordingly, the magnetic field detected by the Hall element **71** becomes stronger, and the potential generated by the Hall element **71** becomes higher.

FIG. **17** shows changes of the output value from the Hall element **71** of the cartridge **40** of the second embodiment in a process in which the cartridge **40** is mounted onto the printer **1**. In FIG. **17**, the horizontal axis indicates time, and the vertical axis indicates the output value from the Hall element **71**. Time 0 is a time point at which the cartridge **40** is mounted at the predetermined position in the space C.

Before the cartridge **40** is mounted at the predetermined position in the space C (when the cartridge is not mounted at the predetermined position in the space C), the output value from the Hall element **71** is kept at a ground potential (0V) (see the "Cartridge not mounted" range shown in FIG. **17**). The output value from the Hall element **71** increases from the ground potential to Vl when the cartridge **40** is mounted at the predetermined position in the space C and electrical connections between the terminals **170***c* through **177***c* and terminals **170***p* through **177***p* are achieved. After that, the output value from the Hall element **71** increases gradually from Vl to Vh in a process in which the valve **60** moves from the closed position to the open position. While the cartridge **40** is mounted at the predetermined position in the space C, the output value V from the Hall element **71** is higher than the ground potential and lower than the power-source potential (Vmax) ($0<V_{min}<V_l\leq V\leq V_h<V_{max}$) regardless of the position of the valve **60** (see the "Cartridge mounted" range shown in FIG. **17**).

If the output value V from the Hall element **71** is higher than or equal to Vmin and lower than Vmax ($V_{min}\leq V<V_{max}$), the controller **100** determines that the cartridge **40** is mounted at the predetermined position in the space C (S**1**: YES). If the output value V from the Hall element **71** is lower than Vmin ($V<V_{min}$), the controller **100** determines that the cartridge **40** is not mounted at the predetermined position in the space C (S**1**: NO).

In S**9** of FIG. **11**, if the output value from the Hall element **71** is lower than or equal to the threshold value Vt, the controller **100** determines that the valve **60** is at the closed position (S**9**: NO). If the output value from the Hall element **71** exceeds the threshold value Vt, the controller **100** determines that the valve **60** is at the open position (S**9**: YES).

Next, the third embodiment of the invention will be described while referring to FIGS. **18**A and **18**B. The third embodiment has substantially the same configuration as the first embodiment, except that the magnet **72** is omitted and that the valve main body **62** of the valve **60** is made of a magnet that generates a magnetic field, not a magnetic body.

In the third embodiment, when the valve **60** is at the closed position as shown in FIG. **18**A, the valve main body **62** (a magnetic-field generating member and a movable member) is directly below the Hall element **71**, and the magnetic field generated by the valve main body **62** reaches the Hall element **71**. In other words, the Hall element **71** is disposed in the magnetic field formed by the valve main body **62** (a magnetic-field forming section). In this state, the magnetic field detected by the Hall element **71** is strong, and the Hall element **71** generates a high potential.

When the valve **60** moves from the closed position shown in FIG. **18**A to the open position shown in FIG. **18**B, as the valve main body **62** separates from the Hall element **71**, the magnetic field detected by the Hall element **71** becomes weaker and the potential generated by the Hall element **71** becomes lower.

The changes in the output value from the Hall element **71** in the third embodiment are similar to those in the first embodiment (FIGS. **14**A and **14**B). In the present embodiment, because the valve main body **62** serves as the magnetic-field generating member and the movable member, reliability in mounting determination can be improved with a simple configuration.

Next, the fourth embodiment of the invention will be described while referring to FIGS. **19**A and **19**B. The fourth embodiment has substantially the same configuration as the first embodiment, except that the valve **60** is omitted, that the hollow needle **153** is made of a magnetic body, and that the process S**9** in FIG. **11** is different.

As shown in FIG. **19**A, when the hollow needle **153** is not inserted in the supply channel **43***a*, the magnet **72** (the magnetic-field generating member) does not confront the hollow needle **153** (the movable member) in the vertical direction Z. That is, the hollow needle **153** is located at a position not between the Hall element **71** and the magnet **72**. At this time, the magnetic field detected by the Hall element **71** is weak, and the Hall element **71** generates a low potential.

As shown in FIG. **19**B, when the hollow needle **153** penetrates the plug **50** and is inserted into the supply channel **43***a*, the hollow needle **153** is disposed at a position confronting the Hall element **71** and the magnet **72** in the vertical direction Z (that is, a position between the Hall element **71** and the magnet **72**). With this movement, the magnetic field generated by the magnet **72** reaches the Hall element **71** efficiently via the hollow needle **153**. At this time, the Hall element **71** is disposed in the magnetic field formed by the magnet **72** and the hollow needle **153** (cooperate to serve as the magnetic-field forming section). Accordingly, the magnetic field detected by the Hall element **71** becomes stronger, and the potential generated by the Hall element **71** becomes higher.

The changes in the output value from the Hall element **71** in the fourth embodiment are similar to those in the second embodiment (FIG. **17**).

In S**9** of FIG. **11**, the controller **100** determines whether the hollow needle **153** is inserted in the supply channel **43***a*, not whether the valve **60** is located at the open position. Similar to the second embodiment, if the output value from the Hall element **71** is lower than or equal to the threshold value Vt, the controller **100** determines that the hollow needle **153** is not inserted in the supply channel **43***a* (S**9**: NO). If the output value from the Hall element **71** exceeds the threshold value

Vt, the controller **100** determines that the hollow needle **153** is inserted in the supply channel **43***a* (S9: YES). Accordingly, in the fourth embodiment, "Valve closed" and "Valve open" in FIG. **17** should be read as "Hollow needle not inserted" and "Hollow needle inserted", respectively.

Further, in the fourth embodiment, the position determining section M**12** determines the position of the hollow needle **153**, based on the output value from the Hall element **71**.

According to the fourth embodiment, the valve is not provided at the cartridge, and insertion of the hollow needle **153** can be detected with a simple configuration of the magnet **72** and the Hall element **71**. Further, the open position and the closed position can be switched with a simple configuration of linear movement (insertion and removal) of the hollow needle **153**.

With the above-described second through fourth embodiments, effects similar to those of the first embodiment (the effect that reliability in mounting determination can be secured while suppressing a cost increase of the cartridge, and the like) can be obtained.

Next, the fifth embodiment of the invention will be described while referring to FIGS. **20** through **22**A and **22**B. In the cartridge **40** of the present embodiment, a photo sensor (optical sensor) is used instead of a magnetic sensor.

As shown in FIGS. **20** and **21**, the cartridge **40** has a housing **41** of substantially a rectangular parallelepiped shape, an ink pouch (ink accommodating section) **42** disposed in the housing **41** and filled with ink therein, an ink leading pipe **43** in fluid communication with the ink pouch **42** at one end thereof, a first valve **50**, and a second valve **60** (see FIGS. **22**A and **22**B).

As shown in FIG. **21**, the housing **41** is defined such that two chambers **41***a* and **41***b* are formed therein. The ink pouch **42** is disposed in the chamber **41***a* at the right side. On the other hand, the ink leading pipe **43** is disposed in the chamber **41***b* at the other side.

As shown in FIGS. **21**, **22**A, and **22**B, the ink leading pipe **43** has a pipe **44** connected with a connection section **42***a* provided at the ink pouch **42**, and a pipe **45** fitted to one side (the left side) of the pipe **44**. The ink leading pipe **43** is formed with an ink channel **43***a* extending in the main scanning direction and being in fluid communication with the ink pouch **42**. The both pipes **44** and **45** of the present embodiment are made of transparent resin. Because the pipe **45** is made of transparent resin, a photo sensor **66** described later is capable of detecting a valve member **62**.

As shown in FIGS. **22**A and **22**B, an annular flange **47** is formed at one end of the pipe **44**. As shown in FIGS. **21**, **22**A, and **22**B, an annular protrusion **48** having an O-ring **48***a* is formed at the flange **47**. Thus, as shown in FIG. **21**, the O-ring **48***a* seals between the housing **41** and the annular protrusion **48**. Note that the flange **47** is a part of the wall of the chamber **41***b*, and constitutes a part of the housing **41**.

As shown in FIG. **20**, a contact **91** is formed on the outer surface of the flange **47**. The contact **91** is disposed to be juxtaposed to an ink discharge port **46***a* described later in the sub-scanning direction. The contact **91** is electrically connected with the photo sensor **66** described later.

A power input section **92** is provided at the side surface of the housing **41** at the ink discharge port **46***a* side. A stepped surface **41***c* is provided between the ink discharge port **46***a* and the power input section **92** of the housing **41**, the stepped surface **41***c* being concaved from the flange **47** toward the ink pouch **42** in the main scanning direction. The power input section **92** is disposed on the stepped surface **41***c*. The power input section **92** is electrically connected with the photo sensor **66**. The power input section **92** supplies the photo sensor **66** with electric power by being electrically connected with a power output section (not shown) of the printer main body.

As shown in FIGS. **22**A and **22**B, the first valve **50** is disposed in the pipe **45** of the ink leading pipe **43**. The first valve **50** has a sealing body (elastic body) **51** that seals an opening (outlet of ink) formed at one end (the left end) of the pipe **45**, a spherical body **52**, and a coil spring **53**. A lid **46** is provided at one end of the pipe **45**, so that the sealing body **51** does not come off from the pipe **45**. An ink discharge port **46***a* is formed in the lid **46**.

One end of the coil spring **53** is in contact with the spherical body **52**, and the other end of the coil spring **53** is in contact with a stepped portion **45***a* formed at the other end of the pipe **45**, and the coil spring **53** constantly urges the spherical body **52** toward the sealing body **51**. In the present embodiment, the coil spring **53** is adopted as an urging member. However, an urging member other than the coil spring may be adopted as long as the spherical body **52** can be urged toward the sealing body **51**.

The sealing body **51** is made of elastic material such as rubber. Further, the sealing body **51** is formed with a slit (penetrating hole) **51***a*, an annular protrusion **51***b*, and a curved portion **51***c*. The slit (penetrating hole) **51***a* penetrates the center of the sealing body **51** in the main scanning direction. The annular protrusion **51***b* can be fitted to one end of the pipe **45**. The curved portion **51***c* is a surface confronting the spherical body **52** and formed along the outer circumferential surface of the spherical body **52** in a part surrounded by the annular protrusion **51***b*. The diameter of the slit **51***a* is smaller than a hollow needle **153** described later. Hence, when the hollow needle **153** is inserted in the slit **51***a*, the sealing body **51** elastically deforms such that the inner circumferential surface of the slit **51***a* makes close contact with the outer circumferential surface of the hollow needle **153**, so ink does not leak from between the slit **51***a* and the hollow needle **153**.

The inner diameter of the annular protrusion **51***b* is slightly smaller than the diameter of the spherical body **52**, and the slit **51***a* is sealed due to contact with the spherical body **52**. Note that the slit **51***a* is also sealed due to contact between the curved portion **51***c* and the spherical body **52**.

In this configuration, as shown in FIG. **22**B, when the hollow needle **153** is inserted into the slit **51***a* through the ink discharge port **46***a*, the distal end of the hollow needle **153** abuts the spherical body **52**, and the spherical body **52** moves to separate from the curved portion **51***c* and the annular protrusion **51***b*. At this time, the first valve **50** changes from the closed state to the open state. When the first valve **50** is in the open state, because the hole **153***b* of the hollow needle **153** has passed the slit **51***a*, the hollow needle **153** is communicated with the ink channel **43***a*. On the other hand, as the hollow needle **153** moves in a direction of pulling out of the slit **51***a*, the spherical body **52** moves in a direction of approaching the annular protrusion **51***b* due to urging of the coil spring **53**. Then, when the spherical body **52** makes contact with the annular protrusion **51***b*, the first valve **50** changes from the open state to the closed state. Further, as the hollow needle **153** moves in the direction of pulling out, the spherical body **52** makes close contact with the curved portion **51***c*. In this way, the first valve **50** takes one of the open state for allowing fluid communication of the ink leading pipe **43**, and the closed state for blocking fluid communication of the ink leading pipe **43**, depending on insertion and removal of the hollow needle **153**.

As shown in FIGS. **22**A and **22**B, the second valve **60** has a valve seat **61**, a valve member **62**, and a coil spring **63**. The valve seat **61** is made of elastic material such as rubber, and is disposed such that its flange **61***a* is interposed between an annular protrusion **44***a* and a stepped portion **45***a*, the annular protrusion **44***a* protruding from the inner circumferential surface around the center of the pipe **44**. In the center of the valve seat **61**, a hole (opening) **61***b* is formed to penetrate in the main scanning direction, and the pipe **44** can be communicated with the pipe **45**.

One end of the coil spring **63** is in contact with the valve member **62**, and the other end of the coil spring **63** is in contact with a connection section **42***a*, and the coil spring **63** constantly urges the valve member **62** toward the valve seat **61**. In other words, the coil spring **63** urges the valve member **62** in a direction toward the sealing body **51**, and the valve member **62** makes contact with the right end portion of the valve seat **61** (opening edge of the hole **61***b*), thereby blocking fluid communication of the ink channel **43***a*. That is, fluid communication between the pipe **44** and the pipe **45** is blocked, and the second valve **60** becomes the closed state. At this time, the right end portion of the valve seat **61** is elastically deformed due to the urging force of the coil spring **63**. Further, the coil spring **63** urges the valve member **62** toward the sealing body **51**, and the elements constituting the first and second valves **50** and **60** are aligned on a straight line along the main scanning direction. Hence, the first and second valves **50** and **60** can be opened and closed by insertion/removal of the hollow needle **153** described later into/from the sealing body **51**. In addition, the second valve **60** can be constituted from a simple configuration, so that failures of the second valve **60** can be reduced.

The valve member **62** has a cylindrical shape, and is slidable on the inner circumferential surface of the pipe **44**. Further, the end surface of the valve member **62** at the connection section **42***a* side has a convex shape that its center protrudes in the main scanning direction. And, by fitting the coil spring **63** to this protruding portion of the valve member **62**, the coil spring **63** is fixed to the valve member **62**.

A pushing member **70** is disposed in the ink leading pipe **43**. When the hollow pipe **153** is inserted, the pushing member **70** pushes and moves the valve member **62** in a direction opposite the urging direction of the coil spring **63**. The pushing member **70** is a cylindrical bar-shaped member extending in the main scanning direction, and is formed integrally at the end portion of the valve member **62** at the valve seat **61** side. In other words, the valve member **62** and the pushing member **70** constitute a movable member. The pushing member **70** has a diameter smaller than the diameter of the hole **61***b*, and is disposed to extend through the hole **61***b*. The pushing member **70** has such a length that, in a state where the valve member **62** is in contact with the valve seat **61** (the second valve **60** is in the closed state), a gap is formed between the distal end of the pushing member **70** and the spherical body **52** located at a position when the first valve **50** changes from the open state to the closed state (when the spherical body **52** makes contact with the annular protrusion **51***b* from a state separated from the sealing body **51**).

In this configuration, as shown in FIG. **22**B, after the hollow needle **153** is inserted and the first valve **50** becomes the open state, the spherical body **52** makes contact with the distal end of the pushing member **70**. And, as the hollow needle **153** is further inserted, the pushing member **70** and the valve member **62** move to separate the valve member **62** from the valve seat **61**. With this operation, the second valve **60** changes from the closed state to the open state. At this time, because the pipes **44** and **45** of the ink channel **43***a* are communicated with each other, ink in the ink pouch **42** flows into the hollow needle **153**. On the other hand, when the hollow needle **153** is removed, in a similar manner to the first valve **50**, the valve member **62** and the pushing member **70** move due to urging of the coil spring **63**, and the valve member **62** makes close contact with the valve seat **61**. With this operation, the second valve **60** changes from the open state to the closed state. In this way, the second valve **60** also takes one of the open state for allowing fluid communication of the ink channel **43***a* of the ink leading pipe **43**, and the closed state for blocking the fluid communication, depending on insertion and removal of the hollow needle **153**.

The photo sensor **66** connected with the contact **91** is provided in the chamber **41***b* of the housing **41**. The photo sensor **66** is a reflection-type optical sensor that is capable of detecting an existence of an object in a non-contact state. The photo sensor **66** is disposed at a position confronting the downstream end of the valve member **62** when fluid communication of the ink channel **43***a* is blocked by the second valve **60** as shown in FIG. **22**A, and at a position not confronting the valve member **62** when fluid communication of the ink channel **43***a* is not blocked by the second valve **60** as shown in FIG. **22**B.

As the photo sensor **66**, for example, a reflection-type optical sensor having a light emitting portion and a light receiving portion may be adopted. In this case, a mirror surface capable of reflecting light is formed on at least part of the valve member **62** (the movable member). In the present embodiment, the light emitting portion and the mirror surface of the valve member **62** serve as the optical-field forming section.

When the photo sensor **66** confronts the valve member **62** (the closed state), light emitted from the light emitting portion is reflected by the mirror surface of the valve member **62**, and this reflection light is received by the light receiving portion. At this time, the photo sensor **66** outputs a high output value indicating that the light receiving portion receives light (corresponding to Vh in FIGS. **14**A and **14**B).

On the other hand, when the photo sensor **66** does not confront the valve member **62** (the open state), light emitted from the light emitting portion is not reflected by the mirror surface of the valve member **62**, and the light receiving portion does not receive light. At this time, the photo sensor **66** outputs a low output value indicating that the light receiving portion does not receive light (corresponding to Vl in FIGS. **14**A and **14**B).

These output values are transmitted to the controller of the printer via the contact **91**. By receiving these signals, the controller can detect the open state and the closed state of the second valve **60** in a distinguishable manner.

Similar to the above-described embodiments, the controller determines that the second valve **60** is at the open position if the output value from the photo sensor **66** is lower than or equal to the threshold value Vt (for example, $Vt=(Vh+Vl)/2$) ($V \leq Vt$), and determines that the second valve **60** is at the closed position if the output value from the photo sensor **66** exceeds the threshold value Vt ($Vt<V$).

Like the Hall element shown in FIG. **14**B does, the photo sensor **66** of the present embodiment generates a potential higher than a ground potential ($V=Vmin>0$) when the photo sensor **66** is disposed in an optical field of magnitude 0 (that is, when the light receiving portion receives no light at all).

According to the above-described configuration, even if the cartridge **40** is mounted at the predetermined position of the printer while the second valve **60** is at the open position, the photo sensor **66** does not output a potential that is the same as the ground potential (a potential inputted to the controller when the cartridge **40** is not mounted at the predetermined position). Accordingly, the controller does not determine that the cartridge **40** is not mounted at the predetermined position despite a fact that the cartridge **40** is mounted at the predetermined position. Accordingly, in the present embodiment, too, an error in mounting determination can be suppressed, and reliability in mounting determination can be secured.

Note that the photo sensor **66** is not limited to the reflection-type optical sensor and, for example, a transmission-type optical sensor may be used.

While the liquid cartridge and the liquid ejecting apparatus of the invention have been described in detail with reference to the above embodiments thereof, various changes and modifications may be made therein without departing from the scope of the claims.

For example, in the above-described first through fourth embodiments, the movable member and the magnetic-field forming section (the magnetic-field generating member, the magnetic body) have configurations in respective patterns, but may have configurations in different patterns. For example, in the fourth embodiment, a pattern can be conceived that the hollow needle **153** is made of the magnetic-field generating member (magnet) and that the magnet **72** is omitted.

<Terminals of Cartridge>

The terminals may be provided separately on a plurality of boards. Further, the power-source terminal, the ground terminal, and the output terminal need not be arranged on the same plane.

The shapes of the terminals are not limited to rectangular shapes but may be any shape such as circular shape, for example. Further, distances between the terminals need not be equal.

The surface on which the terminals are arranged need not be the surface perpendicular to the mounting direction of the cartridge to the mounting section, and may be a surface parallel to the mounting direction, for example.

The number of the sensor-signal output terminal(s) may be changed in accordance with the number of the magnetic sensor(s). Further, the number of the ground terminal(s) may be an arbitrary number that is larger than or equal to one.

The power-source terminal may be electrically connected only with the magnetic sensor, so as to input a power-source potential only to the magnetic sensor. For example, the power-source potential may be inputted to the memory **141** (storage section) via a data input terminal.

Further, the number of the power-source terminal(s) may be an arbitrary number that is larger than or equal to one. For example, an individual power-source terminal may be provided for each of a plurality of magnetic sensors.

The arrangement, the sizes of the terminals, and distances between the terminals may be changed arbitrarily. For example, in FIG. **7**, the positions of the data input terminal **173***c* and the data output terminal **172***c* may be switched. The positions of the sensor-signal output terminals **170***c* and **171***c* may be switched. The power-source terminal **174***c* may be arranged at the right-lower end, the left-upper end, the left-lower end, or the like, not the right-upper end, or may be arranged at a position other than an end of a row. Further, the number of row(s) in which terminals are arranged, the number of terminal(s) included in each row, and the like are also arbitrary. Additionally, terminals may be arranged in a circular shape, or in a random shape, not in rows.

The storage section may be omitted, and the terminal for the storage section may be omitted.

<Terminal of Apparatus Main Body>

The terminal of the apparatus main body may have the same size as or a larger size than the terminal of the cartridge.

The number or arrangement of the terminal(s) of the apparatus main body may partially correspond to the terminals of the cartridge. For example, in a case where the terminals of the cartridge are arranged in two rows each including three terminals, the terminals of the apparatus main body may be arranged in two rows each including four terminals. In this case, the terminals of the apparatus main body include terminals that do not contact the terminals of the cartridge. Similarly, the number or arrangement of the terminal(s) of the cartridge may partially correspond to the terminals of the apparatus main body. The terminals of the cartridge may include terminals that do not contact the terminals of the apparatus main body.

The terminals of the apparatus main body may be terminals of a leaf-spring type (terminals urged by leaf springs in a direction toward the terminals of the cartridge) or may be other than a leaf-spring type. Further, the terminals of the apparatus main body and the terminals of the cartridge may be so designed that positions other than centers of the terminals serve as contact portions.

The movable member that moves in the channel is not limited to a valve that opens/closes the channel, and may be a valve that adjusts a flow amount in the channel or other arbitrary members.

<Magnetic Sensor>

The number of the magnetic sensor(s) provided at the cartridge may be an arbitrary number that is larger than or equal to one.

In the above-described embodiments, the magnetic sensor (Hall element **71**) is used that generates a potential higher than a ground potential when disposed in a magnetic field of magnitude 0. However, a magnetic sensor may be used that generates a potential that is the same as the ground potential when disposed in a magnetic field of magnitude 0.

In the above-described embodiments, the magnetic sensor (Hall element **71**) is used that generates a potential lower than a power-source potential when the cartridge is mounted on the mounting section. However, a magnetic sensor may be used that generates a potential that is the same as the power-source potential when the cartridge is mounted on the mounting section.

The arrangement of the magnetic sensor and the magnetic-field generating member may be changed appropriately. For example, the magnetic sensor may be disposed at an arbitrary and appropriate position in a magnetic field that is generated by the magnetic-field generating member and the movable member (the hollow member in the fourth embodiment).

<Other Configuration of Cartridge>

The ground potential is not limited to 0V, as long as it is lower than the power-source potential.

In the above-described embodiments, the cartridge individually stores two kinds of liquid (black ink and pre-coat liquid). However, the cartridge may store only one kind of liquid.

Data stored in the storage section are not limited to particular kinds of data. As data relating potential generated by the magnetic sensor, the amount of liquid within the liquid storing section, and the like, the storage section need not store the potential and the amount of liquid within the liquid storing section themselves. Instead, the storage section may store data from which the potential and the amount of liquid can be derived.

The storage section need not store sensor output values. The sensor output values are data (Vh, Vl) that serve as criterion for judgment of the position of the movable member (the valve main body **62** in the first through third embodiments, the hollow needle **153** in the fourth embodiment). In this case, for example, the sensor output values may be stored in the ROM of the apparatus main body, and the position determining section may determine the position based on the output values from the magnetic sensor and on data (Vh, Vl) read out from the ROM.

In addition, without departing from the scope of the claims, the configurations (shapes, positions, etc.) of each part (the housing **41**, the reservoir **42**, the supply pipe **43**, the plug **50**, the valve **60**, the sensor unit **70**, the memory **141**, the board **142**, etc.) of the cartridge may be changed appropriately. Further, other parts may be added, and some parts may be omitted.

<Controls Performed by Apparatus Main Body>

Regarding determination by the mount determining section, in the above-described embodiments, it is determined that the cartridge is mounted on the mounting section when the potential V is Vmin≤V<Vmax (see FIGS. **14**A, **14**B, and **17**). However, the range is not limited to the above range as long as the potential is higher than a ground potential. For example, it may be determined that the cartridge is not mounted on the mounting section in the case of V=ground potential, and it may be determined that the cartridge is mounted on the mounting section in the case of V>ground potential.

Regarding determination by the position determining section, in the above-described embodiments, Vh and Vl are used as the potentials serving as criterion for judgment of the position of the movable member, but other values may be used. For example, without using data unique to the cartridge such as Vh and Vl, the position may be determined by using Vmax and Vmin stored in the ROM of the apparatus main body, for example, based on the threshold value Vt=(Vmax+Vmin)/2. The calculation method of the threshold value Vt is also arbitrary. Further, the threshold value Vt itself, not Vh and Vl etc., may be stored in the storage section of the cartridge or in the ROM of the apparatus main body.

The apparatus main body may stop an operation of each section of the apparatus main body (an ejecting operation of the head, etc.), without reporting an error.

Timing at which transmission and reception of signals are allowed between the cartridge and the apparatus main body and timing at which power supply is allowed from the apparatus main body to the cartridge are not limited to those described above. The timings can be changed arbitrarily.

Writing of data by the writing section and determination of abnormality by the abnormal-writing determining section may also be performed prior to reception of a print command from an external device.

Timing at which each functioning section performs a function, such as timing at which the reading section reads data stored in the storage section of the cartridge, timing at which the writing section writes data in the storage section of the cartridge, timing at which the receiving section receives a signal from the magnetic sensor, timing at which the abnormal-writing determining section determines abnormal writing, timing at which the abnormal-reception determining section determines abnormal reception, timing at which the moving section moves the hollow member, and the like may be changed appropriately.

The hollow member may have a tip that is not acicular like a needle.

Liquid stored in the liquid cartridge is not limited to ink and pre-coat liquid. For example, the liquid may be post-coat liquid that is ejected onto a recording medium subsequent to recording in order to improve image quality, cleaning liquid for cleaning the conveying belt, and the like.

The number of the cartridge(s) included in a liquid ejecting apparatus may be an arbitrary number larger than or equal to one.

The number of the liquid ejecting head(s) included in a liquid ejecting apparatus is not limited to two, but may be an arbitrary number larger than or equal to one. For example, the liquid ejecting apparatus may be a color inkjet printer including heads that eject black ink and ink in three colors (magenta, cyan, and yellow).

The liquid ejecting apparatus may be a line type or a serial type. Further, the liquid ejecting apparatus is not limited to a printer, but may be any liquid ejecting apparatus such as a facsimile apparatus, a copier, and the like.

What is claimed is:

1. A liquid cartridge comprising:
- a liquid storing section defining a liquid storing chamber that stores liquid;
- a channel section defining a channel in fluid communication with the liquid storing chamber;
- a field forming section including a movable member that is movable in the channel and configured to form a field that changes depending on a position of the movable member;
- a power-source terminal configured such that a power-source potential is inputted thereto;
- a ground terminal configured such that a ground potential is inputted thereto;
- a sensor electrically connected with the power-source terminal and the ground terminal, the sensor being configured to generate a potential based on the position of the movable member by being disposed in the field formed by the field forming section; and
- an output terminal electrically connected with the sensor and configured to output the potential generated by the sensor,
- wherein the sensor is configured to generate a potential higher than the ground potential regardless of the position of the movable member.

2. The liquid cartridge according to claim **1**, wherein the field forming section comprises a magnetic-field forming section configured to form a magnetic field that changes depending on the position of the movable member; and
- wherein the sensor comprises a magnetic sensor that is disposed in the magnetic field formed by the magnetic-field forming section.

3. The liquid cartridge according to claim **2**, wherein the magnetic-field forming section comprises a magnetic body serving as the movable member, and a magnetic-field generating member that generates a magnetic field.

4. The liquid cartridge according to claim **2**, wherein the magnetic sensor is configured to generate a potential higher than the ground potential when the magnetic sensor is disposed in a magnetic field of magnitude of zero.

5. The liquid cartridge according to claim **2**, wherein the magnetic sensor is configured to generate a potential lower than the power-source potential regardless of the position of the movable member.

6. The liquid cartridge according to claim **2**, wherein the magnetic-field forming section comprises a magnetic-field generating member that generates a magnetic field; and
- wherein the magnetic-field generating member is configured to serve as the movable member.

7. The liquid cartridge according to claim **2**, wherein the magnetic-field forming section comprises a magnetic-field generating member that generates a magnetic field; and
- wherein a hollow member comprising a magnetic body inserted in the channel from outside is configured to serve as the movable member.

8. The liquid cartridge according to claim **1**, wherein the power-source terminal, the ground terminal, and the output terminal are arranged on a same plane.

9. The liquid cartridge according to claim **1**, wherein the movable member comprises a valve body capable of selectively taking an open position of opening the channel and a closed position of closing the channel.

10. The liquid cartridge according to claim **9**, further comprising a valve seat provided in the channel,

wherein the movable member is movable in a region closer to the liquid storing section than the valve seat in the channel, the movable member being capable of selectively taking the closed position at which the movable member makes contact with the valve seat by urging force toward the valve seat and the open position at which the movable member is spaced away from the valve seat against the urging force.

11. The liquid cartridge according to claim **1**, wherein the movable member is linearly movable between an open position of allowing fluid communication between inside and outside of the liquid storing chamber and a closed position of prohibiting fluid communication between the inside and the outside of the liquid storing chamber.

12. The liquid cartridge according to claim **1**, wherein the field forming section comprises an optical-field forming section configured to form an optical field that changes depending on the position of the movable member; and

wherein the sensor comprises an optical sensor configured to generate a potential based on the position of the movable member by being disposed in the optical field formed by the optical-field forming section.

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